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THE STEAM LAUNCH "CINDERELLA."

By "PADDLEFAST."

THIS boat shows some very good and novel features. The total weight is very small, the draft of water light, and the engine simple and easily got at. The speed of the boat is above the average. Added to these is the important advantage that the yacht may be easily run by one man, who both tends the engine, fires, and steers.

The length over all is 30 ft. 10 in.; beam, 5 ft. 3 in. The draft, aft, when in motion, is 32 in., but, as is shown by Fig. 1, the lower edge of garboard strake is from 8 in. deep at bow to 14 near stern; a very small displacement for a propeller. The external planking is ¼ in. cedar, and total weight is less than a ton.

The boat was built under supervision of Mr. William Baxter, of Newark, N. J., well known in connection with the Baxter engines. The cylinder is 4 by 4 in., mounted on four columns, which allow easy access to all the parts; between the two after columns is the pump, coupled to the connecting-rod guide; in front of the forward columns is the eccentric and reversing lever. In the latter, Mr. Baxter has introduced an important improvement, on which a patent has been applied for. It consists, briefly, of a lever, shown at A, Fig. 1, actuating a slide, L, Fig. 3, which slips on the shaft. This slide is diagonally grooved, and fits into reverse grooves in the cam. As L is slid into the eccentric, the center of the eccentric moves from *e*, Fig. 4, to *f*, varying the cut-off to any extent, or reversing the engine. As the boiler supplies plenty of steam with easy firing, the engine is often run with steam at full stroke.

The boiler is 22 in. in diameter and 36 in. high, with 87 one and one fourth inch tubes and 255 sq. in. grate surface. The furnace is 15 in. high. There is a superheater of one 8 in. diameter central globe, and nine 4 in. globes around it. The usual steam pressure is from 75 to 100 lbs. At the latter pressure Mr. Baxter states the engine makes 325 revolutions, and the speed of the boat is between 10 and 12 miles per hour. Nine hours steady running consumes one barrel of coal.

The propeller is a true screw, similar to the Delamater with the corners of the blades rounded off. The number of blades is two; diameter, 26 in.; pitch, 36 in.

The steering gear is exceedingly convenient, consisting of the usual tiller and an endless wire rope passing round outside the coaming through occasional eyes, and four pulleys at A, B, C, and D, Fig. 2. The short sections of rope which pass through the pulleys are cotton or hemp, and shrink so when wetted as to make steering laborious. It is therefore suggested to replace the pulleys by yokes, or levers, as shown by the dotted lines. By this simple apparatus, the steersman, with one hand, may control the boat's course in any part or on either side of the boat; and sitting at E, with furnace door at F, he has engine and boiler in easy reach. The coal bunkers are under the seats, and ample fresh water tanks are placed under the floor at G and H. The owner tried salt water, but the boiler foamed dangerously, and blowing out was impossible, concequently he was much troubled with scale.

One word should be added in regard to the legal inspection of these small steamers. As their general rise is but recent, the law is not adapted to them, and an inspector may legally exact as great a tax upon a 15 ft. pleasure steamer as on a large vessel. According to existing laws, the annual expenses on these diminutive craft, which are seldom used longer than three months in the year—are as follows;

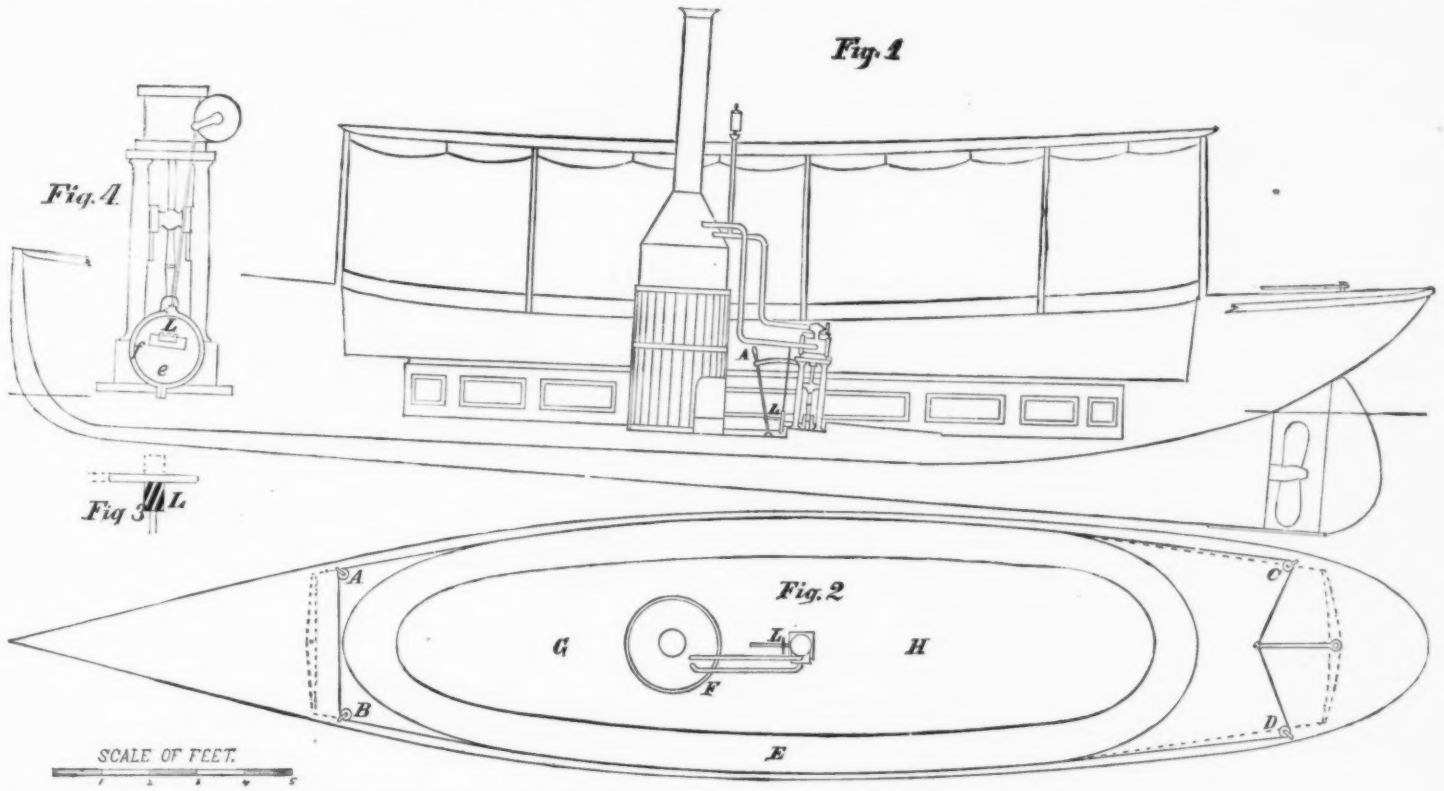
Boiler inspection	$25
Engineer's license	10
Pilot's license	10
Amount	$45

It is therefore proposed by some to petition Congress for some modification of the present inspection laws suited to these small boats.

MECHANICAL STOKERS AND SMOKE PREVENTERS.

THE requirements of these reactionary times are forcing manufacturers in all branches of industry to observe economy in every department. Guided by the experience of recent years, and guessing the probable results of trade agitations, the employers of labor are ever on the alert for any and every invention claiming to economize either labor or materials. Chief among the many subjects that occupy the attention of steam users is that of "How to save fuel?" As the price demanded for labor goes up so must the cost of producing coal, thus increasing the necessity for ascertaining how best to economize a material on which so much depends, and to which we are indebted for so much of our national greatness. Ignorance as to the conditions to be observed in the proper treatment of coal has caused an enormity of waste that we look back upon as being deplorable. Only a few years ago did this question begin to receive that attention its importance demands, when, stimulated by a desire to counteract the effects of repeated strikes, which occasion losses to employer as well as to the employed, efforts were made in the direction of economy; and, to induce the inventive genius of the country to bestir itself in attempting a solution of the difficulty, premiums were placed at the disposal of scientific societies by some philanthropic individuals. One of the most useful and immediate results was the holding of an "Exhibition of Appliances for the Economical Consumption of Fuel," in Peel Park, Salford, during the summer of 1874. This was under the auspices of "The Society for Promoting Scientific Industry," and liberal response was made by inventors, as over 300 exhibits were shown illustrative of this important question—then one of the hour. Noticeable in the class relating to "Appliances which may be adapted to existing furnaces, and whereby an improved combustion of the fuel is secured, and a direct diminution of the quantity required is effected," and attracting most attention from steam users, were various ineffectual all the other arrangements. Thus it will be seen that mechanical stoking does not consist of merely feeding the fuel, but of doing much more, so it will not be necessary to refer so far back as over fifty years ago, when John Stanley made the first success worth mentioning. Hundreds of patents have been taken out since then, and would require more space than we can devote to a review, so we select the latest and most noteworthy.

In 1869 Haworth and Horsfall patented an appliance consisting of a hopper that moved to and fro in front of the boiler, and pushed the slack through holes into the furnace, where wrought-iron scrapers drew it down inclined bars on to the tubular water-bars below. Between these bars a raker ascended, and, cutting into the fuel, broke it up and carried it backward to the bridge, where, as refuse, it was deposited through a shoot into the ashpit. The economy of fuel was considered very great, but the mechanism used was so complex, that, as we were informed by an engineer who had had six of them for two years, "they needed repair so frequently, that they took up the time of a mechanic." By Simpson's system, patented in 1875, slack, or powdered coal, is mixed with proper proportions of air and injected into the furnace by a "Roots Blower." A measuring cylinder was used for regulating the supply of air. The structural alterations necessary for applying these are extensive, besides the building of three or four walls at the bottom of the flue. J. M. Stanley, in 1873, used a steam jet introduced into the fuel chamber, where it joined the bottom of the hopper, and had valves for regulating the pressure of steam in the injection. An American has simplified this, and added a sliding plate for closing the aperture when coal is



THE STEAM LAUNCH "CINDERELLA." WILLIAM BAXTER, ENGINEER.

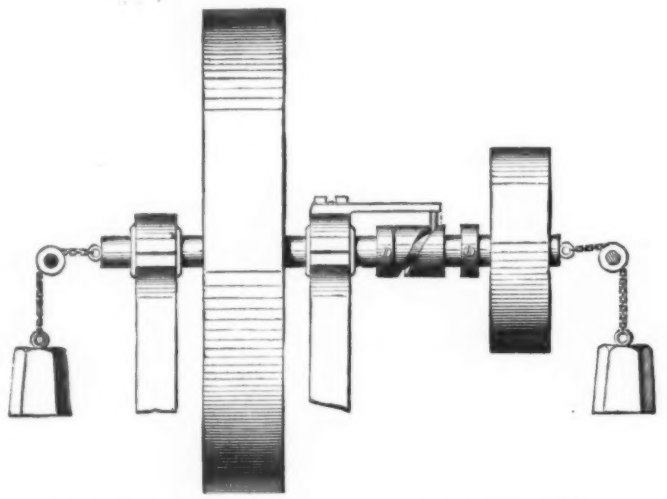
not passing through. There have been many patents taken out for "under feeding," and we will notice two which we have seen. W. Young's plan is to place a spiral grate in bearings on level with the furnace bars. Underneath this, and leading back to the fire, is a trough or well for the fuel. A turn of the revolving grate drags the fuel under and into the fire at back. By mechanism being applied, the motion can be continuous for feeding as desired. The constant "shifting" prevents "clinker," and there is no smoke. This, however, is only applicable to upright boilers. Frisbie has a different method of "fuel feeding from below," and the mechanism is very complex. Some idea of its action may be formed by taking a section of a large band pulley, and placing the shaft in bearings so as to allow the pulley surface to rub against the bottom of the furnace. In continuation of the pulley plate is a chamber with loose bottom. By depressing a lever at side the pulley comes forward and down for being charged with coals, a lift of the lever sends it back, until the chamber is immediately opposite an aperture in the furnace bottom, when the coals are pushed up by the piston acting under the loose bottom. By a set of levers and radial arms the filling and feeding is done by two movements. Under feeding is more suitable to furnaces used for chemical purposes, or where slow combustion is desirable. Another aspect is shown by the inventions of J. Smith, of North Britain, and H. Smith of Halifax. The first named, in 1874, proposed to substitute for the old fire bars longitudinal screws, threaded right hand and left hand in equal number. The two middle bars were placed a little lower than the others, so as to keep the fuel from the sides. These screw bars projected in front, and were worked by gearing wheels and a double worm, which turned one-half in opposite way to the others, and thus kept the fuel moving toward the bridge. H Smith, two years later, brought out a modification of these. He only takes out three bars and inserts troughs with augur-like screw bars working in bearings and below level of other bars. These troughs merged into a larger one under the hopper, the fuel being drawn into the furnace by the revolving screws. As we have not seen any of these we cannot say how far the fuel goes before it is pushed up into the fire, and it is doubtful whether this method is equal to the prevention of slag at the sides. In proceeding to examine the more useful appliances which combine feeding and cleaning, we may just mention Mr. Lancaster's "crusher." This is different from all the others, and consists of a conical hopper, the insides of which are fitted with vertical cutting blades. A vertical shaft slightly coned the reverse, is also fitted with like cutters, and turning in a direction opposite to the cutting edges on the hopper, crushes the coal before it passes to the feeding fans below. We can well imagine what a smash there would be when a hard substance like iron got in with the coal—something must give way, and then a stoppage for repairs. When visiting Owen's College last week we saw MacDougall's stoker in the exhibition. The novelty in this is the manner in which the fire bars are kept moving. At each end is a notch and shoulder for resting on cross bearings. In front a shaft, turned in three different centres, and forming a series of eccentrics in opposite directions, revolves and moves the bars alternately to the back, whilst a ratchet wheel and lever at bridge end bring the other bars to the front again. This gives a broken and undulating motion to the fuel. The ordinary hopper is supplied with a loose bottom inclined to the furnace, and is agitated so as to shake the fuel into the sliding plate that conveys the fuel into the bars.

We also visited the Permanent Exhibition, Blackfriars street, Manchester, where we examined Wilson's machine, which, with the improvements he intends making, we believe will stand a very good chance of succeeding. In the first place, we noticed that, instead of the attendant having to throw the coals into the hopper, which is above his head, the fuel was placed in a well on the ground level and at the side of the furnace. An endless chain of buckets, *à la* dredger, dipped in and being charged, pass up on an incline to the hopper and there deposit, where a plunger shaft feeds it to the fans in the casing below. The peculiarity, however, is in the fire bars, which are of reticular form and work transversely. A cam and speed pulley regulate the speed imparted to the traversing levers. The inventor claims that by these bars the fuel is more thoroughly broken up and turned over on its way to the back. As this is of recent date, only a few are as yet in use, which are, however, giving satisfaction.

The machine known as the "Henderson Stoker" is the embodiment of various improvements on Dillwyn Smith's, and is made by the Mechanical Stoker Company. The fuel is placed in the hopper in the usual way, and broken by a revolving crusher, which beats nearly against a pressure plate, which is regulated by a screw. This plate is of cast-iron, and is intended to break in the event of foreign substances getting in with the coal. As they are supplied at a shilling each, and quickly removed and replaced, this is an advantage, for, as something *must give*, it is well to know the remedy and to have it simple and ready. The pulverized fuel is then dropped on to horizontal fans, which are actuated from below by contact with friction wheels, and by them distributed evenly and regularly over the fire. The furnace doors are fitted with sliding gratings for regulating the supply of air, and within are three gauze partitions which baffle the rush of air and also keep the doors cool. The furnace bars are kept moving by a peculiarly ingenious rocking crank and eccentric arrangement which move one-half the bars—say odd numbers—to and fro only, whilst the other half—even numbers—moves up and down. Thus, when the "up and down" bars are descending, and get below the level, the others move towards the bridge end and carry the fuel with them and come back when freed by the ascending bars lifting the fuel. The air spaces between the bars begin at the front one-sixteenth and widen to three eighths at the back. The automatic gearing used for the "rocking" can be thrown out, and thus allow the attendant to impart a violent shaking to the bars by using a lever inserted in the rocker tube. The space over the ash-pit is covered by a swinging grating on a level with the bars. This is used for depositing the ash below, and is opened and closed by means of a chain running to the front. Of these stokers, nearly 1,500 being in use, we had heard much in praise, and we resolved to ascertain, if possible, how far they were deserving; so, accompanied by Mr. Henderson, the patentee, and Mr. Bennis, one of the company's representatives, we went over to Ashton, and visited three of the largest mills where these stokers are in use. The first place was Mr. Raynor's, the Albion mills, where there are twelve at work. Through the courtesy of the chief engineer, we were enabled to gather the following facts:—1. An entire prevention of smoke. This we could see by comparing the white discharge from these furnaces with the black volumes just then issuing from the neighboring chimneys. 2. In the saving of coal to the extent of 12½ per cent. 3. An increase of steam power. 4. Absence of slag, the refuse coming away in form of ash. 5. A cool stoke-hole. We were in it nearly an hour and a half and felt no inconvenience on leaving. 6. Hand-firing could be done the same as before the use of these machines. This we could understand, as the fires were banked up in our presence during dinner hour. On opening one of the doors we saw a uniform layer of fuel 6 in. deep (Mr. Henderson prefers 4 in.), and all glowing. The flame was clear, and covered every part of the furnace. The six boilers were indicating 1,800 H.P., and were using 105 tons of Cleveland slack per week, as against 120 tons before getting these stokers. We learned that another maker's machines had been tried for two years, but had to be discarded in favor of those supplied by the Mechanical Stoker Company. We then visited Messrs. Oldham & Whittaker's Mills, where eighteen had been in use for four years. More satisfactory results were attained here than at Mr. Raynor's, from the "Weekly Statistics of Fuel and Steam," kept by the manager, Mr. Wallworth, and through whose courtesy we were allowed to examine it. In 1873, when hand-firing was in practice, they used 190 tons of coal per week for eight boilers, indicating 1,450 H.P. Since using the mechanical stokers, they only use 137 tons of coal per week for eight boilers, and increase the I. H. P. to 1,900. This is equal to a saving of fuel to the extent of one-third, a great consideration where such large quantities of coal are used, as at this place and that of the Hurst Mill Company, close by, where there are 22 stokers in use. From this it would appear that with these mechanical stokers seven boilers can do the work of eight where hand-firing is done. We may add that during our visit we saw over 50 of these stokers in operation.—*Textile Manufacturer.*

A SIMPLE AND EFFICIENT MECHANICAL MOVEMENT.

THERE is in use among the file grinders a very simple and efficient mechanical movement not generally known. The grindstones used in file grinding are, when new, about 6 feet in diameter and have about an 8-inch face. The files are held in a fixed position as regards the breadth or face of the stone, and would therefore wear grooves in the stone unless the latter were moved laterally. To obtain such a movement the device employed in our engraving is resorted to. The shaft to which the stone is attached must be able to move lengthways through the pillow blocks. On one side of the stone (outside the pillow block and between it and the driving pulley) there is placed a sleeve, an easy working fit upon the shaft, and having a cam and return groove on the outside. Into this groove there projects a stationary pin, supported by an arm or bracket. The shaft has a



A SIMPLE AND EFFICIENT MECHANICAL MOVEMENT.

weight attached to each end by a cord running over a pulley: The operation is self-acting as follows: The shaft revolving causes the sleeve to revolve by friction, and the pin causes the sleeve to move endwise, its end face abutting against the face of the collar on one side, or the face of the pulley on the other side, as the case may be, causes the shaft to travel in that lateral direction. When the pin has arrived at the end of the groove, the stone ceases lateral motion (there being left a little play between the faces of the sleeve and of the collar and pulley face for this special purpose) while the cam travels in the opposite lateral direction, getting fairly in motion until it strikes the face, when it slowly crowds the face over in traveling to the right, as shown in our engraving; it crowds against the face of the pulley hub, and in traveling to the left against the face of the collar; the latter being fast upon the shaft. The swing thus given to the stone is a slow and very regular one, the motion exciting surprise from its simplicity and effectiveness, especially when it is considered that the friction of the rotation of a shaft about 2¼ inches diameter in a smooth hole about 6 inches long is all that is relied upon to swing so ponderous a stone.

THE FIRST LOCOMOTIVE, THE STOURBRIDGE LION.

A CORRESPONDENT of the New York *Times*, writing from Honesdale, Pa., August 8, gives the following account of the Stourbridge Lion, some remains of which were on exhibition at the Centennial:

"On August 8, 1829, 48 years ago to-day, the first locomotive that ever turned a driving-wheel on a railroad track in America was run at this place on the newly-finished road that connected the Lackawanna coal fields with tide-water on the Hudson, by way of the Delaware & Hudson Canal. The road in question was the first of any general commercial importance ever built in this country, and inaugurated the economical system of inclined planes since adopted by engineers wherever practicable. Up to the 8th of August, 1829, there were only 12 miles of railroad in operation in America—3 miles of a 5-foot gauge running from the Quincy granite quarries to the Neponsett River in Massachusetts, and the novel mule road, 9 miles in length, connecting the Summit Hill Coal Mines, back of Mauch Chunk, with the Lehigh River. The road between Honesdale and [illegible] dale was 16 miles in length, and was the result of the enterprise and persistency of Maurice and William Wurts, the pioneer coal operators of the Lackawanna Valley, who introduced the first anthracite coal into New York City. Railroad building was, at the time mentioned, just beginning to awaken interest among capitalists. The first great enterprise of the kind—the Liverpool & Manchester Railway in England—had been in process of construction some time, and was approaching completion. George Stephenson, the father of steam locomotives, was struggling with the managers of that company for the introduction of steam as a motive power on the road. His experiments had attracted attention in this country. Pending the decision as to whether locomotives should be used on the Liverpool road, Horatio Allen, who had been Jervis' assistant engineer in the construction of the Delaware & Hudson Canal, went to England to examine into the merits of steam as applied to transportation on railroads. He was satisfied that Stephenson's idea would revolutionize all branches of commerce, and, acting on his judgment, Mr. Jervis, by authority of the company, commissioned him to purchase 3 steam locomotives for use on the pioneer road of America. George Stephenson was at the time busy in preparing his subsequently famous engine, the Rocket, for trial on the Liverpool & Manchester Railway. Allen contracted, therefore, with other machinists—Foster, Rastwick & Co., of Stourbridge—to construct the machines for the American company. About the middle of May, 1829, one of them reached this country in the ship John Jay, and was landed at the foot of Beach Street, New York. The West Point Foundry Yard was at the foot of that street. Mr. Allen put the machine together, and, blocking its wheels clear of the ground, exhibited its workings by means of steam generated with coal that had been brought from the mines the engine was intended to transport cars from. For six weeks the wonderful machine was visited by thousands. Then it was sent up the North River to Rondout, and from there forwarded in boats up the canal to Honesdale.

"The intention of the company had been to open the road and canal, and celebrate the running of the locomotive on the Fourth of July, 1829, but the work was delayed so that it was not ready for use until the 1st of August. The locomotive had arrived on the 23d of July. When the road was in readiness the engine was set up on the company's coal dock, under direction of Mr. Allen. This primitive railroad track consisted of hemlock rails, 8 inches by 10 in thickness, placed 4 feet 3 inches apart, and spiked to hemlock ties, with a space of 10 feet between them. The timber had not been well seasoned, and being put down under a midsummer sun, was warped and twisted out of all regularity by the time the trial of the locomotive was to be made. The road ran for nearly a quarter of a mile along the coal docks, facing the village, which had sprung suddenly from the wilderness at the back of the canal, and had been named Honesdale, in honor of Philip Hone, formerly Mayor of New York, and a patron of the great coal enterprise. After quitting the docks, the track turned abruptly to the west by a curve of most threatening radius, and crossed the Lackawanna River over a hemlock trestle, nearly 100 feet high. When the ponderous locomotive was placed on the track, the impression became general that it was too heavy to be borne by the hemlock rails, and Mr. Allen was importuned by many prominent men among the vast assemblage of spectators not to attempt the crossing of the trestle. He saw the great danger at a glance, but feeling that locomotive power on railroads was destined to become universal in years to come, the pride of possessing the distinction of having been the first man to direct the energies of the first one on the continent overpowered his sense of danger, and he declared that he would make the trip, let the consequences be what they might. He steamed up the engine, and after running it slowly backward and forward on the dock in sight of the assembled hundreds for a few minutes, he pulled the throttle-valve open, and shouting a loud good-bye to the crowd, dashed away from the village, around the curve, and over the shaking and swaying trestle at a rate of speed estimated at 15 miles an hour. He ran several miles up the track, and then returned to the village amid the shouts of the populace and the booming of cannon. Although the locomotive, as a locomotive, was a perfect success, the railroad was not calculated to stand its use; and the expense of adapting it to the weight of the locomotive being too great to call for consideration at that day, the engine was housed in a shanty on the dock, where it lay for years, a prey to neglect and decay. Its boiler was finally taken to Carbondale, where it is in use and excellent order to-day. The pump was used by an employee of the company for several years, and was at last washed away by a freshet and lost. The rest of the machinery was broken up and sold for old iron. The two other locomotives shared the the same fate. Only one or two relics of the pioneer locomotive of America are in existence to-day. The engine was called the Stourbridge Lion, from the place of its manufacture. The machine weighed 7 tons, 4 tons being what the contract called

for. There were 4 wheels, connected by side-rods. Vertical cylinders on each side of the rear end of the boiler communicated motion to a huge walking beam, connected with the side-rods. The engine was covered with rods and joints, and its appearance was that of a great grasshopper. John B. Jervis, who ordered the locomotive, and Horatio Allen, who ran it, are still living, one in Rome, N. Y., the other in New York City. Both have since achieved some of the greatest engineering triumphs this country has known.

"There is another interesting and important fact connected with the running of the Stourbridge Lion. The successful application of steam power to railroads has always been dated from the trial of Stephenson's Rocket, Ericsson's Novelty, and the Sanspareil, and Perseverance, in Liverpool, on the 14th of October, 1820. The Stourbridge Lion demonstrated two months before, in a remote and isolated part of America, that the idea was a grand success."

THE NEW BRIDGE OVER THE DOURO RIVER, PORTUGAL.

THE viaduct projected by the Royal Company of Portuguese Railroads, and designed to traverse the Douro River, near Oporto, Portugal, is near 1,129 feet in length between the faces of the abutments. The roadway is 200 feet above the plane of general comparison, said plane being 38 feet below the level at low water. A central arch crosses the stream and is connected at the upper portion to the sides of the ravine by two lateral viaducts. The depth of the river and the thickness of the clay banks, which it was necessary to traverse in order to plant piles securely, rendered the adoption of the single arch, 512 in span, and supported on the rocks on each side, advisable. On the summit of this arch the roadway rests, while it is also supported by metal trestles which conform in height to the irregularities of the soil.

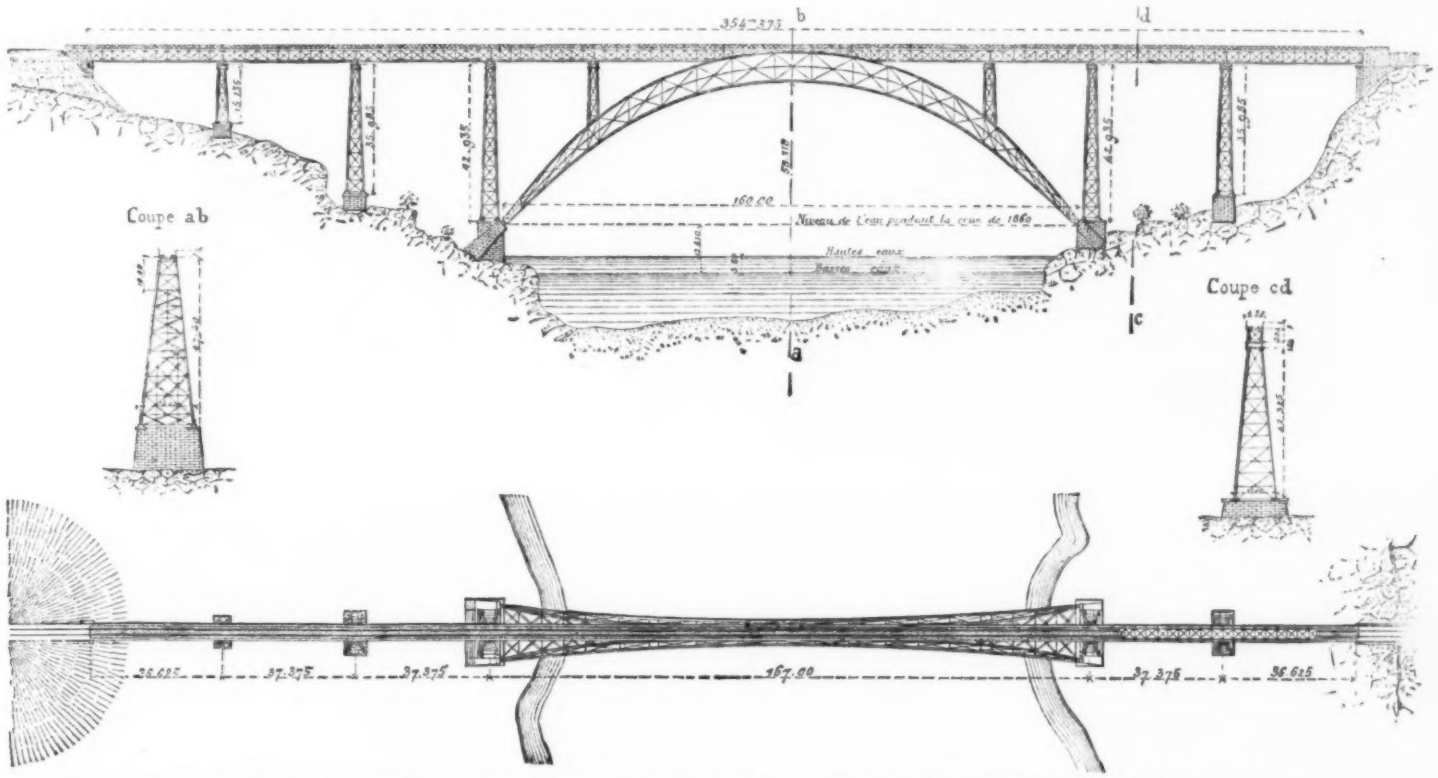
base on the arch abutment, and then on two similar trestles of less height. On the Oporto side there is but one intermediate pillar, as will be clearly seen from the annexed engraving, for which we are indebted to the *Revue Industrielle*. The roadway is so attached to the arch that the latter is free to move without disturbing it. The pillars are entirely of laminated iron—cast iron being rejected as not offering sufficient security. The various dimensions will be found expressed in meters, on the engraving.

ENGLISH RAILWAY TUNNELS.

Name of Tunnel.	Name of Railway.	Length in yds.
Woodhead	M. S. & L.	5,296
Stanedge	L. & N. W.	5,286
Medway	South-Eastern	3,74
Sevenoaks	South-Eastern	3,600
Box	Great Western	3,227
Littleborough	L. & Y.	2,869
Sapperton	Great Western.	2,800
Polehill	South Eastern	2,750
Blea Moor	Midland	2,640
Kilsby	L. & N. W.	2,423
Dove's Hole	Midland	2,420
Shepherd's Well	L. C. & D.	2 376
Wapping (Liverpl.)	L. & N. W.	2,250
Lime Street "	L. & N. W.	2,230
Clayton	L. B. & S. C.	2,200
Brislington (No. 1)	Great Western.	2,200
Sydenham	L. C. & D.	2,190
Abbot's Cliff	South-Eastern	2,000
Watford	L. & N. W.	1,793
Glenfield	Midland	1,782
Mersham	South-Eastern	1,780
Clay Cross	Midland	1,780
Belsize	Midland	1,760
Sapperton	Midland	1,760
Gorah Wood	Newry and Armagh	1,510
White Ball	Bristol and Exeter	1,470
Grenfield	Midland	1,400
Greenfield	North-Eastern	1,364
Thackley	Midland	1,360
Honiton	L. & S. W.	1,350
Bletchingley	South-Eastern	1,324
Lydgate	L. & Y.	1,322
Wickwar	Midland.	1,320
Shanklin	Isle of Wight.	1,320
Shakespeare's Cliff	South-Eastern	1,320
Almonsbury	Bristol and S. Wales.	1,320
Kilbarry	Great S. & W. (Ireland)	1,290
Primrose Hill	L. & N. W.	1,250
Glasgow	Edinburgh and Glasgow.	1,250
Potter's Bar	Great Northern	1,210
Balcombe	L. B. & S. C.	1,122
Brislington (No. 2)	Great Western.	1,100
Elstree	Midland	1,060
North Welwyn	Great Northern	1,046

The Corby tunnel, now being constructed on the Midland new Kettering and Manton line, will be a short distance over a mile in length.

The Medway tunnel, on the South-Eastern, 3,740 yards long, was originally a canal tunnel, and was purchased by the railway company and converted. The longest tunnel in England is the Marsden on the Huddersfield Canal; it is 5,450 yards, or 3 miles 170 yards, and is, therefore, 154 yards longer than the Woodhead railway tunnel.



NEW RAILWAY BRIDGE OVER THE DOURO RIVER, PORTUGAL. 512 FEET SPAN.

Owing to the dimensions of the arch its construction involves some peculiar features. It was, in the first place, necessary to avoid the use of rigid tympanums, in which case the calculations already very uncertain became still more complicated owing to the dilatation, the effects of which would profoundly disarrange the equilibrium of the various parts. It would also be necessary to use an immense quantity of metal in order to ensure the safety of the structure. Tympanums were therefore completely suppressed, the arch being given sufficient rigidity to resist the strains tending to deformation resulting from unequal distribution of the stress. The arch was therefore given considerable vertical thickness, this being 32 feet at the key. At the abutments it was essential that the arch should rest on two supports, as is ordinarily the case on large openings. It thus became necessary that the vertical height should decrease toward the extremities, the extrados and intrados converging on the support. To this end the form adopted is that of an arch of neutral fibers almost parabolic, but the highest of which diminishes from key to abutments. This form is that of a demi lune—the intrados and extrados being besides interconnected by a system of vertical and oblique pieces forming St. Andrew's crosses, so as to ensure the complete solidity of the whole.

A new condition also presented itself due to the resistance offered by the structure to the wind. In order that the violence of tempests might be resisted, it was indispensable that the arch should be broad or at least possess a wide base, as it was obviously useless to make the upper portion wider than the 12·8 foot roadway. The width of the base supports was therefore fixed at 48 feet—as it was necessary to form the central arch as a crescent situated in oblique planes with relation to the vertical, distant 12·6 feet at the upper portion and 48 feet at the base. The arches are connected by a system of vertical frames, placed transversely, formed by horizontal traverses and vertical rising timbers fixed on the arches and the St. Andrew's crosses. Besides, in the planes of the intrados and extrados are strengthening pieces which consolidate the connection between the two arches.

The roadway reposes on each side on a metallic pillar fixed on the spandrel of the arch and is prolonged to the abutments resting on the Lisbon side, on a trestle which has its

ON HEATING FEED-WATER.

By J. HAUG, M.E.

AS SOME doubts seems to exist among steam-users about the advantages of heating the feed-water, it might be appropriate to give a few figures about the economy to be obtained thereby.

To heat a pound of water from zero to the boiling point and convert it into steam at a certain pressure a certain amount of heat has to be imparted to it. A "unit of heat" is the amount necessary to rise *one* pound of water *one* degree in temperature.

Then at 15 pounds above atmosphere 1191 units are necessary.

"	30	"	1198 "
"	45	"	1204 "
"	60	"	1208 "
"	75	"	1212 "
"	90	"	1214 "

Taking 1200 as an average, and assuming the average natural temperature of water at about 50°, we have to impart 1150 units of heat to every pound of water to convert it into steam. A feed-water heater will thus, for every 100° the feed water is raised in temperature, effect a saving of $\frac{100 \times 100}{1150} = 8{\cdot}7$ per cent.; the greatest economy would be attained if the feed could be heated to the boiling point. Taking the latter at 212°, the point would then be

$$\frac{(212 - 50) \times 100}{1154} = 14 \text{ per cent.}$$

In condensing engines the feed-water is taken from the hot well, which generally is kept at 120° to 130°, as a higher temperature would impair the vacuum and thus neutralize what is gained by a higher temperature of feed.

In some marine engines the feed-water has been heated to a higher degree by taking it from the hot well into the top of the condenser, or around or through the exhaust pipe, to expose it to the steam coming out of the cylinder, before it is condensed. Considerable gain has been claimed by inventors of these plans, but as they have not been adopted to any extent it may be doubted whether their advantage is universally acknowledged.

For stationary condensing engines the so-called economizers have found extensive application; they consist of coils or rows of tubes, located in the back flue of the boiler; the feed-water is *forced* through them, and can thus be heated to very near the boiling point. Some of these were shown in the British section, in the south-east corner of Machinery Hall, in the Centennial Exhibition, and very elaborate and costly structures they were. Their vertical tubes had a slow-moving set of scraping rings around them, to keep them free from any soot that might impair their conductive power. Taking the temperature of the hot well at 120°, and assuming that the feed is heated to 200°, the gain would be

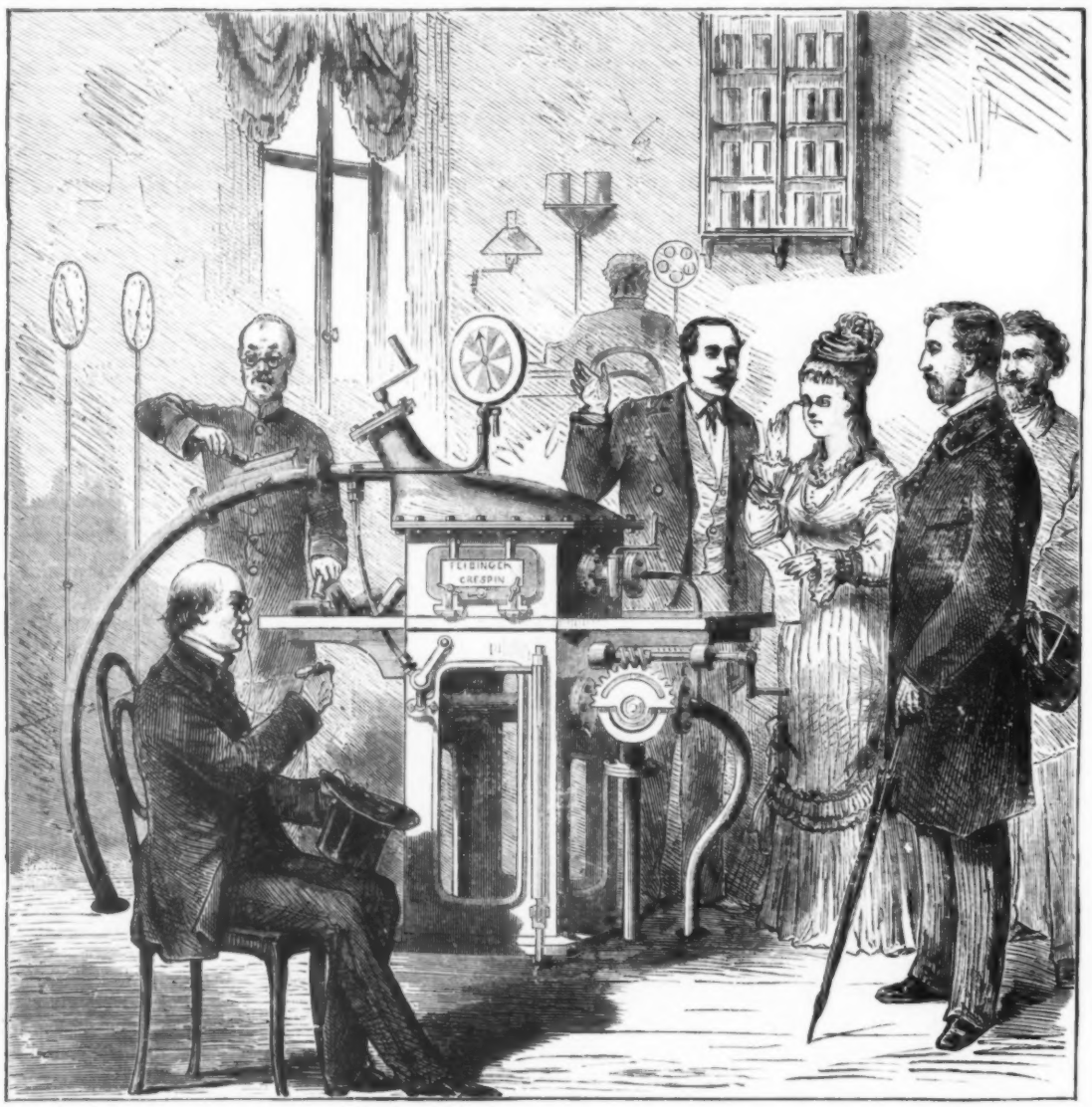
$$\frac{(200 - 120) \times 100}{1200 - 120} = 7{\cdot}4 \text{ per cent.}$$

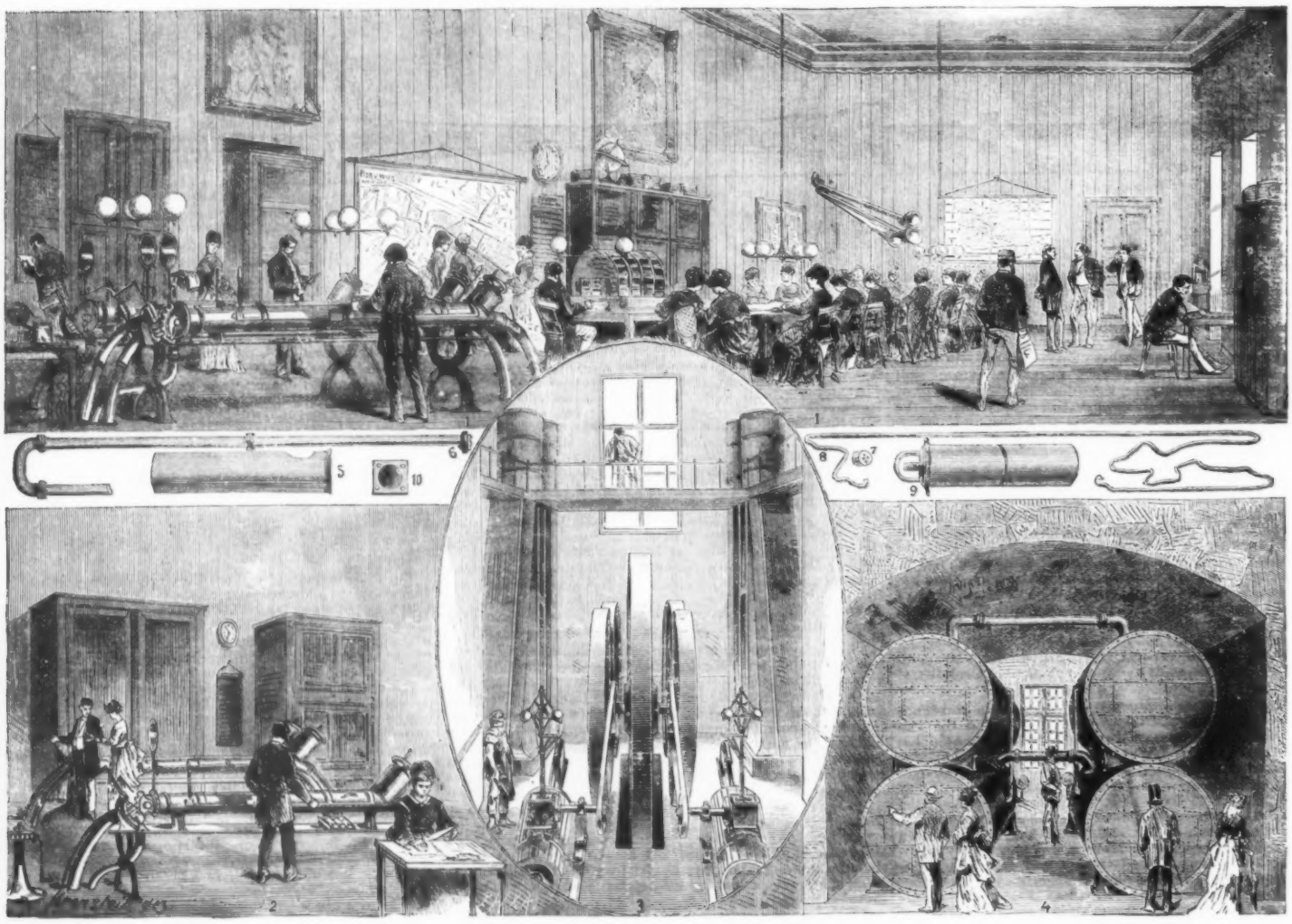
For *non-condensing* engines, where the feed would have to be raised from 50°, the gain would be

$$\frac{(200 - 50) 100}{1250 - 50} = 13 \text{ per cent.}$$

For non-condensing engines the simplest way to heat the feed is by the exhaust from the cylinder, either passing it into the feed-water tank (which is done in locomotives sometimes), or by *forcing* the feed-water through a coil of pipes surrounded by the exhaust steam. Or the feed, in its way to the boiler, is forced through a cylindrical vessel and the exhaust steam conducted through it in small tubes, after the manner of a surface condenser. If these arrangements are provided with sufficient heating surface, the feed may be heated to 180° or 200°, but care should be taken to provide ample and unobstructed passage to the exhaust, so as not to increase the back pressure; for if the latter is only one pound per square inch higher, the loss, especially where the steam is greatly expanded, may come very near the gain by feed heating. In a Corliss engine, working with 60 lbs. pressure, cutting off at 1-10th, the mean pressure is about 14½ lbs. per square in.; if the back pressure is raised 1 lb., the mean pressure would only be 13¼, showing a loss of $\left(\frac{1 \times 100}{14{\cdot}5}\right) = 7$ per cent.

The cost of heating the feed is represented by the interest on the first cost of the heater and its cost of maintenance, and will vary somewhat according to construction, etc. On an average the *net gain* by heating the feed may be assumed as about five per cent for condensing, and 10 per cent. for non-condensing, engines.—*Phila. Review.*





PNEUMATIC POSTAL TRANSMISSION, VIENNA AND BERLIN.

1. Main Station.—2. Branch Station.—3. Air Compressing Steam Engines.—4. Air Receivers.—5 to 10. Receiving and Sending Boxes.

PNEUMATIC POSTAL TRANSMISSION.

To the public works of large cities of the present day belong not only gas and water pipes, street railroads, electric telegraphs, but also the pneumatic mail connections, or "letter tubes," as they may be called. The electric telegraph requires short messages, and a certain time in condensing them, while the pneumatic mail overcomes all that. The same is not obliged to travel over the surface of the earth, as the tubes are placed subterranean, like the gas and water pipes, and within these tubes run, with a velocity of at least 20 meters in a second, the letters inclosed in boxes.

The whole system rests on the principle of the child's toy, in which, through a quill, peas are propelled in forward or backward directions. The function of the tips is taken up by a steam engine, which forms "vacuum reservoirs" by withdrawing all the air therefrom, and "pressure reservoirs" for the compressed air.

The engine of the Vienna Pneumatic Post Office has 20 horse-power. On the stations is a tubular apparatus, as shown in Fig. 2 of our illustration. An electric telegraph connects the stations to give the signals. Letters may be sent at a certain price and up to a certain weight. The letters are placed into a cylindrical box that fits exactly into the interior of the conducting tubes. Back of one or more such boxes is placed a piston that is fitted by leather packing rings tightly into the conducting tubes, and receives directly the pressure of the air from the air reservoirs. On the main station the engine works directly; on the intermediate stations the iron reservoirs, which are filled and emptied thereby. On the receiving station are means to admit the air so as to retard the speed of the boxes, while brakes and buffers prevent too heavy concussions.

The terminals of the conducting tubes are of polished brass, and resemble somewhat large trombones. The subterranean tubes are sometimes heated up by the friction of the air and boxes, and have to be cooled by water, which is forced out again by the air pressure as soon as its object is accomplished. Sharp curves have to be avoided. The system of tubes may also be extended into private and business houses, so as to bring them in communication with one of the stations. In Vienna the system has been successfully worked since March 1, 1875, without any trouble or interruption. The large illustration represents the interior of a main and branch station, of the engine, of the air-compressors, and of the receiving and sending boxes, tubes, etc., of the Vienna Pneumatic Post Office; while the second illustration shows the interior arrangement of a Berlin station.

THE WYANDOTTE, KANSAS, GAS WELL.

THE gas well at Wyandotte, Kansas, is located about one mile above that city, and not more than three miles in a direct line from the court house in Kansas City, Mo. It burns freely without perceptible odor and gives a clear, soft light of about three-fourths the power of our ordinary manufactured gas. Tests made by competent experts show that there is no sulphur or carbonic acid present in it, and that, in all respects, it is exceptionally pure. The water has a strong saline taste and contains, apparently, a large proportion of carbonate of iron.

This gas well was discovered by a company prospecting for coal about three years ago. After boring a five-inch hole to the depth of four hundred feet, the operator reported the drill as having passed through a twenty-inch vein of bituminous coal. Just then the workman at the drill was astonished to hear a bubbling, rumbling sound, roaring like distant thunder. It was the gas freeing itself from confinement below, and forcing ahead of it a large body of salt water, as high as the top of the derrick, drenching the driller completely. Ever since then the pressure of the gas continues to force the water in jets to the surface. This mineral water, although never advertised, is very much used, with good effect, by invalids, both near and far, and the gas (carburetted-hydrogen) has been escaping into the atmosphere, 75,000 feet daily, or enough to light a very large city, ever since.

This Wyandotte gas is used by the company in the furnace for raising steam, and by the owner of the farm where the well is located for cooking and light. The gas, whether flowing or burning, is almost odorless. Its entire freedom from sulphur renders it highly adapted for the reduction of silver and gold ores. Some time ago the Kansas City press advocated the policy of capitalists forming a company for the purpose of reducing at this railroad center Rocky Mountain ores, as is done at the works at Omaha. To moneyed men who contemplated embarking in such an enterprise it will be information to know there is a hydrogen gas belt in this vicinity.

Notwithstanding a coal vein of sufficient thickness to pay was discovered, the company has concluded to abandon coal mining for the present, with its attendant heavy cost for elevating coal from a deep shaft, and utilize this new gas fuel which rises from the depths to the surface of the earth of its own accord and with pressure enough to force itself in any direction desired.

It is not only suitable for heating purposes, but is very valuable for light; it burns with a clear bright flame without purification, and is free from the disagreeable odor accompanying coal gas.

It is similar to the gas used for so many years to light Fredonia, N. Y., and other towns located in the oil regions of Pennsylvania. Scientific men who have visited this well give as their opinion that the gas is produced by the distillation from coal shale and other minerals by the internal heat of the earth, and that the supply is inexhaustible.

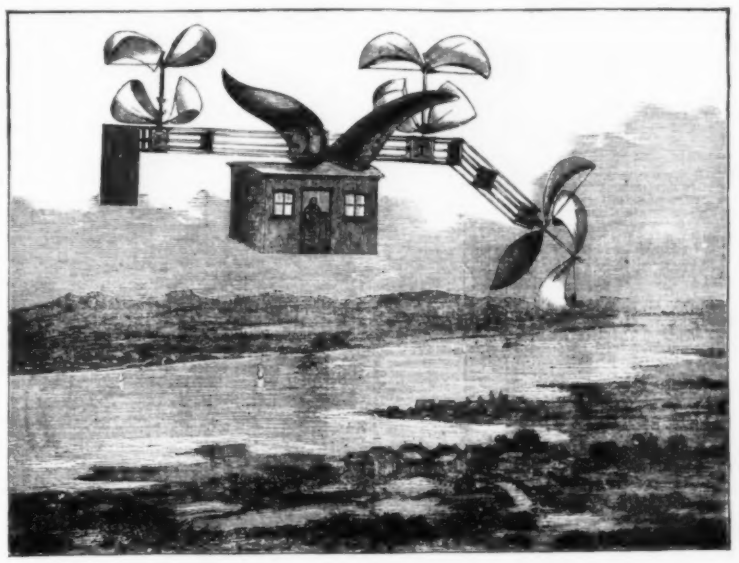
The company, after obtaining the exclusive right to light Wyandotte and Kansas City, Kas., for the term of 20 years, built a tank and gas holder, having a capacity of 40,000 cubic feet daily. Recently they have enlisted some capitalists in their favor, who will furnish the gas mains for the purpose of conveying the gas to light said towns, and ultimately Kansas City, Mo. No company manufacturing gas from coal can compete long with one supplied by Nature with gas free of charge.—*Western Review.*

PUYDT'S PROJECT FOR A CANAL BETWEEN THE ATLANTIC AND PACIFIC.

THE canal, according to M. de Puydt's plan, would start on the Atlantic side from Puerto Escondido, about 140 miles south-east of Panama, and follow the valley of the small river Turgandi, running almost north and south; it would then take a south-easterly direction, and enter the valley of Tanela. It would next be taken to the Cordillera range, which it would cross through a defile between the Mali and Estola peaks. The mouth of this defile, which is the highest point to be overcome, according to M. de Puydt's observations, is at a height of about forty-six mètres above the level of the sea. From that point the canal would be continued on the Pacific side in the valley of the River Pucro, and would follow this stream to its junction with the Tuyra, the chief river of the isthmus, to which it would run parallel for some distance, eventually joining it about sixty-five kilomètres above its mouth. The waterway between the Atlantic and the Pacific would thus be completed. The length of the canal proper would be about 88 kilomètres; it would have no locks, but would not have the same level as the two oceans. There would be a culminating point, the position of which has not yet been definitely fixed, but it would be somewhere on the Pucro. The waters of the higher regions would be collected at this spot, and allowed to flow down by gentle declivities towards the Atlantic and Pacific. M. de Puydt's plan, we may add, is adopted by an association styled the Société Internationale du Canal Colombien.

A NEW FLYING MACHINE.

W. J. LEWIS, of New York, has invented a new aerial vessel, which is interesting on account of its peculiar construction. It consists of an open-work frame, forming an obtuse angle, the frame being made of thin but strong rods or tubes and intended to support the entire mechanism. Two vertical revolving shafts, each of which carries four sail-shaped wings, resembling propelling screws, serves to elevate the machine. At the rear end, on the downward-inclined part of the frame, is a shaft with four wings for forward motion. In the center of the machine is the motor, which sets the wings simultaneously in motion by shafts and bevel gearing. In the center of gravity of the apparatus are two large wings which resemble the wings of a bird, and are intended to raise and lower the apparatus and facilitate the descent. The rudder is at the front end and governed from the cabin built around the motor. Mr. Lewis has built a model which is said to work in satisfactory manner. The motive power was a large watch spring, weighing several pounds. A machine on a large scale is intended to be worked by a treadle machanism, steam or other motor. It is an easy matter to make a small flying machine shoot up a short distance into the air by means of a spring. But to make a large machine, with a steam engine, lift itself and sustain itself in the air is a problem not yet solved.



NOVEL FLYING MACHINE.

PORTLAND CEMENT.

ONE of the qualities of both natural and artificial cements, as distinguished from limes, is their property of the same route; and if the concrete is to be immediately laid, the mixing apparatus, and the men employed in the work, must be accommodated on the narrow excavated ground, and must be moved back as the work proceeds.

The great advantage which would arise if the concrete or mortar could be brought to the ground ready mixed must be apparent to all. To ascertain if this was possible without deteriorating the quality of the work, the author, in 1873, prepared twenty-four blocks of concrete of one cubic foot each, and allowed different periods to elapse between gauging the material and moulding it. These blocks were tested by crushing at the material-testing machine in Birkenhead, belonging to the Mersey Docks and Harbor Board, with the results shown in the table.

It is unfortunate that the power of the machine was limited to fifty tons, and that out of twenty-four blocks, eleven were therefore not broken. But the result proved beyond doubt that on the average these blocks, the concrete of which had stood from twenty to thirty minutes before being placed in the moulds, were actually stronger than those in which the concrete was immediately moulded.

The author is only able to explain this on the assumption that even in this good and well-purged cement there was some free lime which began to slack on the application of water, thus producing numerous but invisible points of weakness in the blocks first moulded; while in those made with concrete, allowed to stand after gauging, the materials were not moulded until the slacking process was completed.

Since the date of those tests about 100,000 yards of concrete have been laid, after being mixed in and carted from the nearest available yard. The rate of progress of the work had been greatly increased, and the results have been in all respects satisfactory.

It is necessary to remark here that although this is a valuable quality of good Portland cement, it would be most dangerous to take advantage of it without making quite certain that the cement is good and not quick-setting.

Use of Portland Cement in Iron-work.—Until Portland cement of good quality was applied for the purpose of making joints between iron and stone-work, there was no entirely satisfactory material for the purpose. The author has used it under a great variety of conditions; and when other conditions failed to keep the tar of a roadway from passing between buckled plates and the arched ribs of a wrought-iron bridge, caulking with Portland cement was perfectly successful. In preserving the bottoms of iron ships it has been long used with the greatest advantage, and in conjuction with iron girder work it is more easily and safely employed than any other material.—*Mr. Deacon.*

RESULTS OF TESTS AS TO THE RESISTANCE TO CRUSHING OF PORTLAND CEMENT CONCRETE BLOCKS, EACH BLOCK 1 FT. CUBE. PROPORTION OF GRAVEL TO CEMENT, 5 TO 1.

Intervals in minutes between gauging concrete and filling moulds.

	0	20	30	40	45	50	60	75	90
Resistance to crushing in tons after 28 days	48.1	50.0	50.0	50.0		47.15	42.15		
Resistance to crushing in tons after 26 days	43.0	48.0	50.0	47.17		47.0	48.15		
Average	45.55	49.0	50.0	48.58		47.07	45.15		
24 days	49.15		50.0		50.0		49.12	43.1	37.1
21 days	50.0		50.0		50.0		46.0	5.00	50.0
Average	49.57		50.0		50.0		47.56	46.55	43.55

quick-setting. This peculiarity is valuable in some plasterer's work, and in pointing joints in running water, where the mortar would otherwise be washed out; but there are probably few other circumstances in which any advantage is derived from the use of very quick-setting cement. On the contrary, it is exceedingly difficult to insure its immediate application after gauging, and any remixing greatly weakens, if it does not altogether destroy, the cohesion.

The best Portland cement has most fortunately the property of setting much more slowly than any other, and it may therefore be used with far greater safety in situations where its application cannot be closely watched.

In certain classes of work it is extremely difficult to place mortar or concrete *in situ* immediately it is mixed. Take, for example, the case of a carriage-way foundation 25 feet wide. The excavated materials must be removed from, and the concrete materials brought to, the face of the work by

STEAM MOTIVE POWER.

THE effect of machinery on the industrial interests of the world generally is a subject that frequently engages attention. According to Dr. Engel, of Berlin, the aggregate steam motive power at present in use in the world is three and one half millions horse power employed in stationary engines, and ten millions horse power in locomotive engines, making a total of thirteen and one half millions horse power. This force is maintained without the use of animal food, except by the miners who dig the coal and provide the fuel, and the force maintained in the muscles is to the force generated by the product labor as about 1 to 1,000. This steam power is equal to the working force of 25,000,000 horses, and one horse consumes three times as much food as one man. The steam power, therefore, is equivalent to the saving of food for 75,000,000 human beings. Again, three

power looms, attended by one man, produce daily seventy-eight pieces of cotton fabric, against four pieces produced by one hand loom, worked by one man, in the year 1800. This, of course, is the merest outline of what is accomplished by the use of steam power and labor-saving machinery.

VALVES FOR GAS AND OTHER PURPOSES.

WE shall confine ourselves to a description of the two kinds commonly used in connection with gas mains and services—viz., the hydraulic valve and the slide valve.

The hydraulic valve has the merit of being more durable and less costly than the slide, and it is certain in its action so long as the water-lute is in order, and the column of water of sufficient depth to counterbalance the pressure exerted upon it. It is not generally so handy of application as the slide, and therefore is principally confined to the pipes on the gas-works, such as the inlet and outlet pipes to the holders, etc., for which it is exceedingly suitable.

Fig. 1 is a sectional view of one form of the hydraulic valve. A is an air-tight cylinder of cast iron, having at its lower part an annular cup formed by the insertion of the end of the inlet-pipe, B, and is nearly filled with water or tar; C is the outlet-pipe, and may be connected to the mains either by a socket or flange; D is an inverted cup of cast iron, 16 inches deep, to the crown of which a rod is secured by a nut; the other end of the rod passes through a stuffing box in the cylinder-lid, and is attached by a cotter to a rack actuated by a pinion, working on a stud on the framework, as shown, for raising and lowering the cup. The latter is represented by resting on the cylinder bottom, and dipping into the liquid, in which position the valve is closed, all communication between the inlet and outlet being shut off by the intervening column of water 12 inches high. On the cup being raised to the upper part of the vessel, a passage for the gas through the valve is established.

Fig. 2 is an arrangement of the same valve, differing from the foregoing only in the method of raising and lowering the cup. In this instance the cup slides upon the screw, which is turned by the hand-wheel. To prevent leakage through the screw-way, a piece of pipe the length of the screw, and plugged at its lower end, is attached to the cup, with which it rises and falls. Two guide-rails extend from the bottom to the top of the vessel, and fit into notches in the cup sides, as shown in Fig. 3, to prevent the latter from turning round when the screw is worked.

Another form of hydraulic valve is represented in the engraving, Fig. 4. In this instance the cup, D, rests in the water or tar at the bottom of the vessel when the passage is open, and when this is required to be closed, it is raised by means of the rod so as to envelope the end of the central pipe, C. A is the inlet branch, and B is the outlet. A wrought-iron pipe is shown at the side; this is for the purpose of attaching a pump to draw off surplus water that might seal the passage.—*Journal of Gas Lighting.*

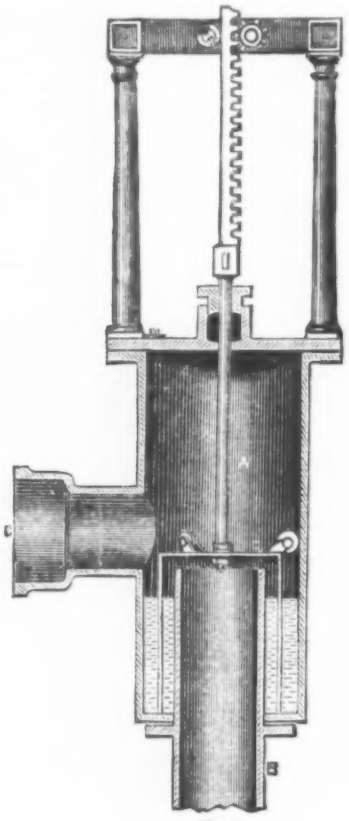


FIG. 1.

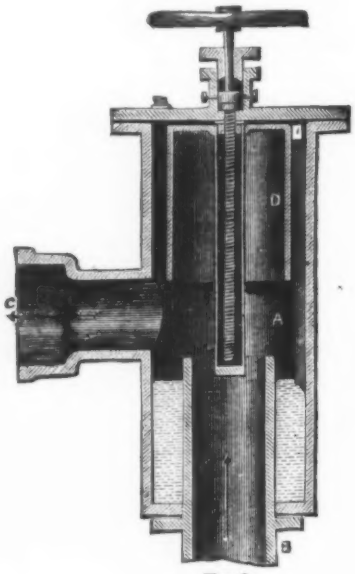


FIG. 2.

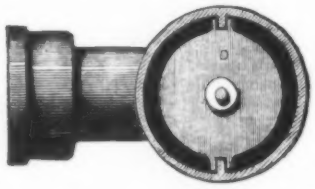


FIG. 3.

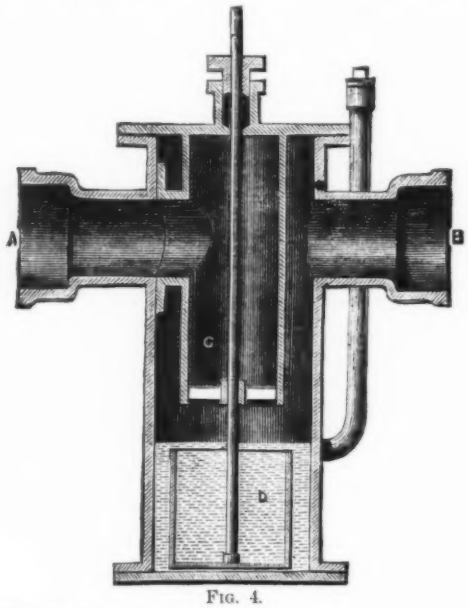


FIG. 4.

VALVES FOR GAS AND OTHER PURPOSES.

BRITISH OFFICIAL REPORTS ON THE PHILADELPHIA EXHIBITION.

EDGE TOOLS, HOLLOW WARE, SAFES, ETC.

MR. DAVID MCHARDY gives a long and elaborate report on this subject, devoted mainly to an examination into the American exhibits in this class. Beginning with edge tools, the first place is given to what may perhaps fairly be called the American tool *par excellence*, the axe. The shape of the American axe, with its uniform taper from crown to edge, is well known even in this country, and the reporter, like all who have used it, was struck with its perfect adaptability to the work it has to perform. Some picks are noticed for a device by which the head is rendered interchangeable. A socket on the handle receives the head which is formed with a recess thereon. The top of the socket fits into the recess, and a wedge prevents the head from slipping. The "lightning saw" tooth is illustrated by a wood cut. This, with many other American saws, was described in the Rev. A. Rigg's Cantor Lectures on "Tools," a series of which Mr. McHardy speaks highly in one part of his report. It is a little curious that the form of tooth now so widely adopted in America closely resembles the "M" tooth of which Holtzapffel, writing in 1856, speaks as being "now but very rarely employed." A simple method of strengthening hand-saws is mentioned. The blade is continued right through the handle, which is formed of two pieces, having between them the handle-shaped continuation of the blade. A saw frame, in which the saw is kept strained without the use of a brace, is also remarked upon. Several varieties of augers are noticed, especially an "expansive boring bit," with an adjustable cutter, for boring large size holes. After a few remarks on the extreme beauty and accuracy of some "tools of precision"—rules, squares, etc.—Mr. McHardy goes on to the planes, in which the ordinary beech stock is replaced by one of cast iron, the sole sometimes being formed of an adjustable slip of steel for planing curved surfaces. This also was fully described by Mr. Rigg. The carpenter's brace, with an expansive chuck to take bits of different sizes, was another tool which attracted the notice of the reporter. The different varieties of parallel and "grip" vises are also noticed. On the files it does not seem to have been practicable to have formed any decided judgment. Many of the Americans were machine made; those most admired by Mr. McHardy were of Swiss, Belgian, or French make.

As regards agricultural and laborers' tools, most of the improved forms now common in England are of American origin, and consequently there appears not to have been much which struck the reporter as new to this country.

The cutlery shown by American exhibitors gave proof of considerable advance. It was stated, however, that Sheffield steel was generally used for the finer branches of cutlery. In considering the whole of this class, Mr. McHardy considers that America took the first place in table cutlery. In pocket and fine cutlery, several Sheffield firms maintained their own reputation. France scarcely did herself justice in this department. The German display of pocket cutlery was "no doubt equal to any from the United States, showing great beauty, and high excellence of finish." "The Russian exhibits from Novgorod showed an advance which we were scarcely prepared to see."

The application of emery in cutting wheels did not come within the scope of the report, but Mr. McHardy comments on the quality of this and other polishing materials.

Some of the ornamental castings attracted great notice, both American and European. A novelty noticed was the utilization of worn-out tin plate by melting it down and casting it into various articles. At Philadelphia this alloy seems only to have been employed for the purpose of making sash-weights, but Mr. McHardy considers it might be applicable for more important purposes. It may on this be permissible to remark that at the present price of iron it can hardly pay even to collect old tins, etc., and the most valuable portion of the alloy, the tin, appears to be wasted, unless indeed the alloy is applicable to purposes for which cast iron alone cannot be used. At present the chief use of tin scrap is to manufacture salts of tin for dyeing purposes. Processes for recovering the metallic tin appear, at least in this country, to be less successful. It so happens that the writer of this notice has had an opportunity of examining specimens of this alloy, which, as Mr. McHardy says, resembles spiegeleisen in its fracture, and is of a surprising hardness.

The next class included in the report comprised bolts, screws, horse shoes, etc. Mr. McHardy specially notices the use made of cold punching, a practical application of M. Tresca's theory of the flow of solids. The work is effected by introducing the element of time, and operating with certain slowness. In another section of this class was "a grander collection of horse shoes, both as regards finish and variety, than has previously been presented to the world."

Some space is devoted to an account of the safes shown. The most novel of these was a spherical safe, the body of which revolved within an outer casing, so that the door was turned round and covered by the solid outer shell. This was an American invention. There were also several other notable safes, including Chatwood's, with its shell of spiegeleisen between two skins of soft steel.

In summing up his observations, Mr. McHardy remarks that it would be idle to ignore the fact that at Philadelphia Great Britain was face to face with her greatest rival. It was obvious that the American manufacturers were on their own ground, and, consequently, at an advantage. For this due allowance must be made. In table cutlery, tools, and safes, America was before Great Britain, and "a strenuous effort will be required from Sheffield to hold its own in the race of progress." Besides the good quality of the American tools, they appeared attractive and well finished.

MILITARY AND SPORTING ARMS, ETC.

In his report on these classes, Major Noble gives a great deal of space to the American collection, which was naturally the largest. Among the ordnance shown there were guns representing several different systems, breech-loaders and muzzle-loaders, principally the former. These are all briefly described and the results given of experiments with them. An account is also given of a series of experiments carried out by the United States authorities, to ascertain whether smooth bores could be advantageously converted into rifled guns. Among the more notable exhibits was an improved Gatling gun. This gun had been fired at the rate of 1,000 rounds a minute, its ordinary rate of rapid firing being about 700 rounds per minute. Fired deliberately at a target 19 feet long by 11 high, range 1,000 yards, it scored 665 hits out of 1,000 shots. Germany had a fine display of artillery by Krupp of Essen. Great Britain sent no ordnance, but the exhibit of sporting small arms was particularly good. The other countries mentioned in the report are France, Russia, Sweden, Spain, Belgium, and Brazil.

RAILWAY APPLIANCES.

Captain Douglas Galton, in his report on railway appliances, confines himself almost wholly to the American exhibits, which, in a class like this, naturally formed by far the largest portion of the whole collection. Besides noticing the principal objects shown, he gives a short account of the railway system of the States as it at present exists, thus continuing and bringing down to date the report which he prepared for the Board of Trade in 1875 on the same subject. The American system grew out of very different wants from those which originated our own. The railway, instead of uniting established centres of commerce, had to open out new districts, to give rise to the growth of towns, and to develop its own traffic. Hence arose a necessity for a road which should, in the first instance, be inexpensive, however much it might afterwards require improvements. The permanent way of the earlier American railways was of the simplest and cheapest character. The line followed the sinuosities of the ground in order to avoid cuttings, and the consequent sharp curves and steep gradients involved certain adaptations in the rolling stock. The stations were also of primitive construction, and it was found less costly to carry on in the cars themselves much of the business which, with our greater local traffic, we conduct in out stations. Tickets, for instance, are both issued and collected in the cars. From similar considerations the signalling system is less developed, while much greater control over the train is given to the engine driver. This necessitates the use of continuous brakes, the Westinghouse being the one almost universally employed. The patent of Smith's vacuum brake has been bought by the Westinghouse Company, and in certain cases this brake is used by them as well as their own. Several other continuous brakes were also noticed by Captain Galton. Among the novelties in the construction of the rolling stock, paper car wheels claim a foremost place. These, as is now well known, are formed of paper compressed by hydraulic apparatus; one was shown which had run 30,000 miles under a Pullman car, and its tire showed but slight marks of wear. The duration of the ordinary cast iron wheels was given at 50,000 to 60,000 miles. Tabular statements are given of the dimensions of several of the locomotives exhibited, and the chief points of difference between English and American engines are commented on. A specimen table, also given, shows the method of calculating and publishing the cost and performance of each engine.

The "fast freight system" is fully described. The principal company working this system is the Empire Transportation Company, which was called into existence to remedy the inconvenience arising from the numerous sections of lines under different proprietorship over which through traffic had to pass. A curious feature in this company's work is its system for the conveyance of petroleum. This is conveyed from the wells by "pipe lines," with force pumps at intervals, by which the oil is conveyed long distances from the wells to stations, where it is delivered into cars.

Some space is devoted to a consideration of the narrow gauge system, which is used to a considerable extent in America. Captain Galton observes that if it could be proved a success in America, this would be a good argument for

employing it in India and in our own colonies. He, however, does not appear to think that these lines are a success. He acknowledges their value as pioneer lines, but says that as in districts where the traffic increases it will always be necessary to replace them with the broader gauge lines, it is generally preferable to construct light railways of the standard gauge in the first instance.

The report concludes with some remarks on the traffic, and the tariffs and the legal enactments connected therewith.

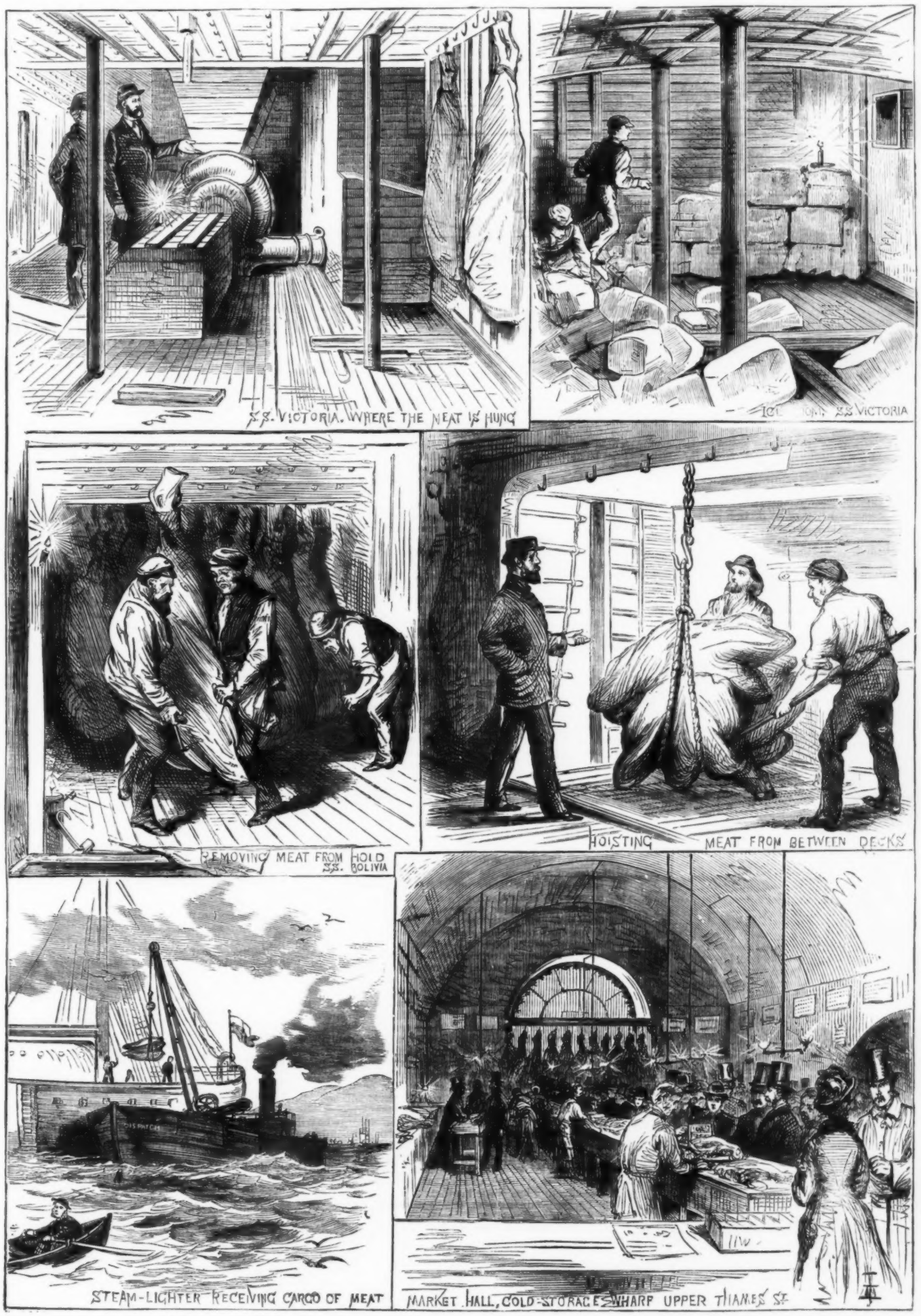
THE FOREIGN FRESH MEAT TRADE.

THE shipment of fresh meats from the United States to Europe, although a trade of comparatively recent origin, has already reached very large proportions, and is constantly augmenting. Several of the large steamers that regularly ply between New York and Liverpool, are now fitted with special apartments for the refrigeration and the preservation in a refrigerated state during the voyage, of meats, fruits, and other perishable products. Our illustrations represent some of these fittings.

At the present time the refrigeration required during the voyage is maintained by means of ice. For this purpose a cargo of ice must be shipped at New York with the meat, so that, in fact, the trade requires the simultaneous shipment of two classes of American products. The vessel is provided with a large apartment which is stored full of great blocks of ice, obtained during the depths of winter from the Hudson River, 75 miles north of New York.

A blowing machine, worked by the steamer's boilers, is provided, which sucks cold air from the ice room and discharges it into the apartment where the dressed meat is suspended. A constant circulation of cold air through and around the meat is thus maintained, and on arrival at Liverpool, the meat is delivered to the butchers in a fresh and sound condition, better prepared for market, indeed, than it was on the day of starting from New York. This method of transferring perishable goods across the Atlantic is so simple that the wonder is that it was not adopted years ago.

We suppose the day is not far distant when all the large steamers will have attachments to their machinery, whereby the necessary refrigeration can be produced without carrying a cargo of ice as is now required. Here appears to be a field for inventors to examine and work.


S.S. VICTORIA. WHERE THE MEAT IS HUNG
ICE CHAMBER S.S. VICTORIA
REMOVING MEAT FROM HOLD S.S. BOLIVIA
HOISTING MEAT FROM BETWEEN DECKS
STEAM-LIGHTER RECEIVING CARGO OF MEAT
MARKET HALL, COLD-STORAGE WHARF UPPER THAMES ST.

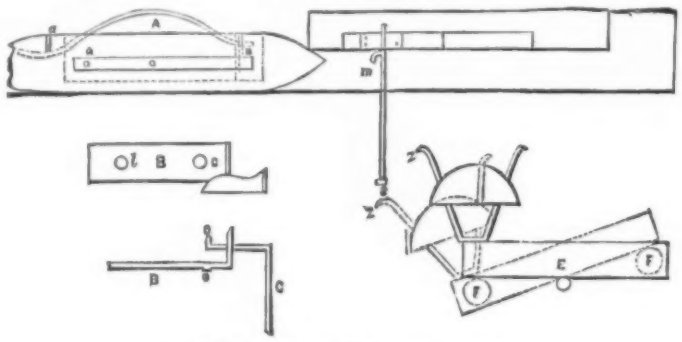
THE FRESH MEAT TRADE BETWEEN NEW YORK AND ENGLAND.

LOOM-STOPPER ALARM.

THE apparatus here engraved is the invention of M. Antoine Démard. Its object is, by an addition to the ordinary shuttle and a small apparatus placed in the gill-box, to announce the occurrence of a broken thread, or a knot, or any other irregularity, and to cause the loom to come to a stand still.

If the arrangement does not include the stoppage of the loom, the alarum ceases to act if the fault is not repeated; but when the loom is brought to rest, of course the attendant has to set it going again after correcting what is wrong.

The apparatus consists of a curved spring, A, made of very flexible steel wire, only fixed to the shuttle by one end, and so arranged that it can be entirely pressed down into the hollow of the shuttle, the pressure being regulated by the screw, *a*. The free end of the spring is engaged in the hole, *b*, in the end of the latch, B, and capable of pivoting around *c* on the right-angled piece, C, which engages with that part of B which is bent up at a right angle. When the latch is free the spring C has a tendency to leave the shuttle and



LOOM-STOPPER ALARM.

stand out to the extent of about the third of an inch, and prevents the latch from escaping entirely. When the loom is going regularly, the shuttle works in the usual way, passing to and fro without bringing the apparatus described into action; but on the appearance of knots and other irregularities, pressure is brought to bear on the spring, A, during the passage of the shuttle through the warp, and the spring acts upon the extremity of the piece, B, making the latch which protrudes from the shuttle, presenting at its extremity the projection, *m*, and causing the hammer to strike the alarum.

For the automatic stopping of the loom an apparatus is employed which consists of a hollow tube, E, closed at both ends, and having a leaden ball within it. This tube has an oscillating power. At the extremity, towards the left hand, this tube is furnished with a piece of iron pipe, bent into branches, as shown in the engraving; one of these branches serves for the hammer to strike against, the other carries a hook. When a fault occurs and causes the stem of the apparatus to act, the stem of the hammer acting on the branch of wire causes the tube, E, to oscillate, when the leaden ball within the tube descends, as shown in the figure, and adds its weight to that of the tube, which allows the latter to retain its position, the hook *z* descends, and the weft is severed.

DESIGNS FOR BRUSSELS CARPETS.

WHAT is wanted just now in designs for Brussels carpets is something in the shape of an entirely novel style. There is at present a great sameness about all patterns of the present day that do not belong to a distinct style, such as the Persian or Turkey. A great number of patterns of a nondescript character have of late years been made, and though many of these are in excellent taste, we venture to think that the public are getting a little tired of them, and want something that shall be clever and new, while the rules of art and good taste shall not be outraged. The designs here alluded to are those numberless little set and all-over patterns, of which every firm shows so many that depend, not upon their design, but upon their colorings for their sale. These will, of course, always be in the market, for the simple reason that they are satisfactory to produce, and because many of them are very pretty. Much has been said by various writers about the carpet being the background of the room, and as such it has been often stated that its outlines must not be vigorous, nor its colorings harsh, and all this is very well; but should not manufacturers consider that, in their desire to attend to these oft-repeated aphorisms, many of the patterns now woven go to the other extreme, and possess no feature of interest whatever, or are sometimes a jumble of unmeaning figures, supposed, and very erroneously, to be Indian, and often depending for their pretty—for we cannot call it good—effect solely upon the little specks of bright and interesting color rising at intervals from the mass? Not only the so-called Indian, but many other carpets of the nondescript description alluded to above depend upon this plan of dotting bright spots of color here and there for their effective appearance, while in the matter of design there is absolutely nothing which the eye can dwell upon with real satisfaction. We should guard against any misapprehension of our remarks by stating here that they do not apply to the true Indian design founded upon carefully conventionalized plants, but only to those which are really of no style, but which consist of a muddled-up mixture of eccentric and useless figures.

A good deal of money is spent by manufacturers upon the production of patterns that turn out to be of no use as salable material, and then some of them console themselves with the idea that among the good there must be a certain number of bad ones to show off the others. It is very easy to say how necessary it is to be careful what designs are bought, and yet the experience of every manufacturer will tell him that occasionally the most apparently stupid and unsalable thing will have a long run, but we are afraid that the knowledge that this is sometimes the case does, now and then, induce the purchase of a design that the better taste of the buyer would otherwise lead him to unhesitatingly reject.

What is necessary, then, is to have a large selection of patterns, with as many good ones as possible, and a few oddities. Where judgment and discretion are used, money spent in this way is not thrown away, and some carpet firms in existence have almost made their reputation by paying attention to this one point, while others—and we could give the names of several, only such a course would be unadvisable—have remained in a standing position, or even gone backward in the race for business, because they have not given sufficient importance to the designing department, and have adopted an unwise policy of parsimony with reference thereto.

While keeping a good selection of the old styles before the public, in new designs and plenty of colorings, the question is, what entirely new style can be brought out? This problem is, we suppose, always agitating the minds of designers, while during recent seasons, at all events, it does not appear that they come any nearer solving it; and while so many men, whose business it is to deal with this question, have not latterly been able to make their decided mark with it, we necessarily approach it with diffidence. Ferns, mosses, scrolls, Japanese, bastard Indian, and lots of other things are pretty well played out; why, then, cannot some return be made to, perhaps, the oldest of all styles, which commenced with the manufacture of Brussels by power, and, perhaps, flourished anterior even to that time?—we allude to the old jewel patterns. We are quite aware of that noteworthy objection to them—the quantity of ground they show, and for that reason should not recommend the production of such designs as were in vogue in the dark ages of the trade, when a few lustrous spots stood at distant intervals upon red or drab grounds; but we do not see why this field should not afford some pasture yet, in the shape of jewels formed directly from plants, and let those of native British growth be preferred, conventionalized, and not placed too far apart, on plain or sometimes diapered grounds. These designs need not be large, and, if clever, would at least be new again to the trade, and would, we think, have a good run and sell. It would, of course, be necessary to choose the good shades with great care, and to the end that these should be right, designers—who are not practical men as to the qualities of yarn useful and looking well in certain colors, of course the most inexpensive and yet effective—would do well to consult with manufacturers upon this point. In conclusion, we would say a word as to a mistake often made by manufacturers when a design is submitted to them for sale, and that is, the ordering it to be materially altered before they will buy it. Some artists make a salutary rule that they will alter nothing, but in these days of competition few can afford to do that, and consequently a fair or good pattern is so "mauled," for there is no other such an expressive term, that the artist, when it is finished, scarcely knows his own creation, is dissatisfied, and, what is more important in a marketable commodity, generally the manufacturer is displeased also, but feels compelled to purchase because he ordered the alterations to be made. The artist ought to know best about his own production; and usually if the design is good, it is good, and if bad, patching will not improve it. We cannot lay this down as a hard and fast rule, of course, but it is none the less correct in the main because it has its exceptions. Taste is so utterly different in different individuals that the very feature that is condemned by one man is praised by the next; hence, it is generally better, where some alteration is contemplated which will materially interfere with the character of a design, to forbear, give the designer special instructions, and let him commence *de novo*, allowing he may sell the other design elsewhere.—*Textile Manufacturer.*

IMPROVEMENTS IN WOOL CARDING.

M. C. SCHNEICHEL, director of the Dessau Wool-spinning Mill, Dessau, writes to the *Deutsche Wollengewerbe* that he has succeeded, after many repeated trials, with the aid he has received by the experience gained in conducting these trials, in constructing an arrangement by means of which the wool is so sufficiently opened as to prevent the possibility of the card teeth being subsequently damaged. This arrangement enables the rollers of the carder to be placed close up to the centre drum, according to requirements, without overworking the cards. The improvement is, moreover, adapted to every wool-carder, and by its use the respective card clothing is subject to no more wear than the card-teeth of the second carding engine are. It effects a better mixing together of the different colors and qualities, than was heretofore possible, besides yielding 25 per cent. more work than other carders. The invention is stated to be equally well suited to vigogne and other kinds of wool-spinning, and recommends itself also in cotton spinning and felt manufacture. The working of this arrangement is such that it is easily adjustable to the quality of fibre to be worked, so that the shortest, longest, finest, or coarsest wools may be worked with equal advantage.

In short, the advantages claimed by the inventor (who will be glad to give any additional information on the nature of his inventions) are—

(1) 60 to 70 per cent. saving in cards, by their longer wear, and not requiring such frequent cleaning and sharpening.

(2) Saving in cleaning, causing saving in time and labor, besides effecting less waste in wool.

(3) Larger productiveness, or about twenty-five per cent. more work turned out.

(4) Better mixing together of dyed wools, and of different qualities.

PRESERVATION OF WINE.—Prof. J. Nessler.—Two parts per cent of salicylic acid are mixed with melted paraffin, and small chips of wood or linen rags are saturated with the mixture and thrown into the casks, where they kill the organisms which promote the formation of vinegar.—*Moniteur Scientifique.*

TESTS FOR HEMP, JUTE, ETC.

THE important subject of the distinguishing of hemp from jute and other fibres is dealt with by M. F. Gouillon in the *Moniteur de la Teinture.*

M. Gouillon says that those who have treated the subject before have generally confounded jute with *phormium tenax*, or have not sufficiently established the difference between them. The methods for these two fibres are:

1. To steep the yarn, or tissue, in nitrous acid of 36 deg., when the nitrous vapor causes jute and New Zealand flax to turn of a dark red color, while flax and hemp only assume a pale yellow color.

2. Steep the material in chlorated water, pretty concentrated, for about a minute, then pour upon it a few drops of ammonia: the *phormium* and *jute* then assume a fine red color, which gradually turns brown, and then disappears, while hemp and flax are but very slightly affected.

M. Gouillon examines these methods critically. He notes, in the first place, that jute is often substituted for hemp, which it resembles closely, and much reduces the quality of the cloths, as jute is affected rapidly by moisture and alkalies.

Phormium is set aside as unimportant, the fibre being too coarse to be mistaken, and hemp and jute alone considered.

Nitric acid fumes, he says, are a test for *phormium tenax*, but not for jute.

The chlorine and ammonia method is common to the two textiles, and give very notable indications of the presence of jute among hemp fibre.

The following is the mode of proceeding recommended: The stuff is pulled to pieces, or the yarn is untwisted, and then worked for five minutes in pretty concentrated chlorated water; it is then wrung out, rinsed, and laid on a plate, or sheet of glass; a few drops of ammonia are then dropped upon it, and the red color already mentioned will appear, and vanish, as already stated. The effect on jute is more marked and more persistent than on phormium. M. G. says the water may either be prepared by passing a stream of chlorine through it till saturated, or in the following manner: Make a milky solution of chloride of lime with water, immerse the material to be tested, and pour upon it a few drops of hydrochloric acid; let it rest for about half an hour, and then add the ammonia, as already mentioned. In this case the action of the chlorine is prolonged, but not too much so; for, if so, no action takes place. It must not be forgotten that these agents act upon the resinous parts of the fibre, and not upon the true fibre itself, which is a cellulose substance similar to other vegetable textile fibres; thus, if the chlorated bath were too prolonged it would dissolve, and carry off the resinous matter, and nothing would be left but the pure cellulose, on which the agents here used have no effect. For this reason phormium, or jute fabrics perfectly bleached by means of chlorine, are easily detected by this method, but they are generally sold unbleached.

Microscopic examination is an excellent method, but everybody does not possess a powerful instrument, or the experience to make use of it. But the polygonal section of jute fibre is very marked with an instrument which enlarges to the extent of five hundred diameters.

But there is another method, which requires no microscope; iodine colors jute a decided reddish-brown, but scarcely has any effect on hemp. The mode of testing with iodine is given as follows: About a gramme of iodide of potassium is dissolved in a hundred grammes of water, and to the solution is added 25 centigrammes of iodine. The material is steeped for two or three minutes in the solution, and is then passed several times through a solution of one gramme of sulphuric acid to a hundred grammes of water. If the test is applied also to real hemp it will be seen that no marked color is produced while the jute undergoes a decided change; when *phormium tenax* is submitted to the same treatment it turns yellow, whereas the jute assumes a fine red. In the iodine method the fibres must not merely be passed through the sulphuric acid solution, but thoroughly washed in it, in order to remove any excess of iodine, for the hemp will otherwise retain sufficient of capilling action to cause it to assume a color which makes it difficult to distinguish it from jute. The color of jute thus treated is of a dull reddish-brown, and persistent. The iodine method thus not only distinguishes hemp from the other fibres, but jute from phormium.

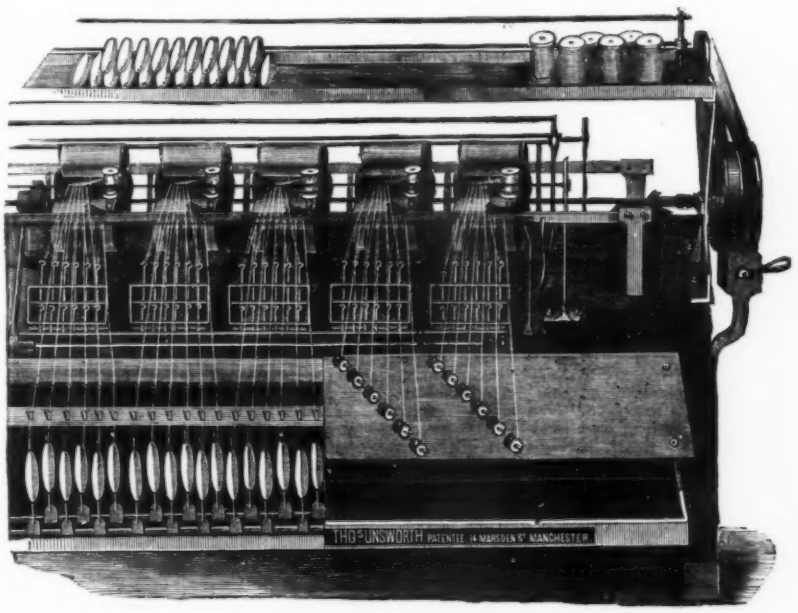
UNSWORTH'S WINDING DOUBLING MACHINE.

COTTON, in its progress from the raw material to the finished article, passes through many intermediate processes. Winding is one of the simplest of these stages. In single thread winding, used in the preparation of yarn for warps, it is probably the most unimportant operation to be met with from the mixing of the raw material to its elimination as a web from the loom. But, passing from the winding of the single thread to the processes in which two or more are bound together, we shall find that it greatly increases in importance. In many classes of textiles the yarns used are two, four, eight, twelve, or any other required fold, and it is in the production of yarns of these classes that the winding becomes a very important process. In the woolen, silk, flax, jute and hemp trades, the use of many-fold yarns is more frequent, perhaps, than in the cotton trade. In the manufacture of these yarns the first and essential requisite necessary to secure a good quality is to obtain a uniform length to the component threads, freedom from "single" or weak places, caused by the breakage of one or more threads and the continued winding on of the remainder, until the dropped end cannot be recovered. It then, in that case, becomes necessary to attach the broken thread to the others, and thus a faulty place passes upon the bobbin, weaker by twenty, thirty, or fifty per cent. than it ought to be. As long as the production of a good quality of many-fold yarn was dependent upon the perfect attention of the superintendent operative, only indifferent and ever-varying results were attainable. The reason of this is that, as human beings are not steam-impelled machines, the best attention that can be given by any operative is only intermittent; external circumstances interfere with it, and fatigue destroys it. In a crowd of workpeople two individuals can scarcely be found alike, and even in the same person the best qualities are constantly varying in quantity. The wondrous progress made in science and art during the past century arises from a recognition of this truth. We have utilized the forces of nature as motors, and they, with tireless energy, work to accomplish the task we appoint them. The employment of human strength is thus superseded, and the principal demand now made is upon the faculty of attention. But even this we find in short supply for the requirement. It becomes a necessity, therefore, that we should take a step further, and by mechanical arrangements enable the blind forces operating our machinery to check, or prevent, the production of

defects. This should be done in every possible case, and the consequence would be quickly apparent in increased efficiency, more uniform results, and greater economy. During the past few years this point has had its importance duly recognized, and the successful adoption of the principle to one machine and then another has had to be chronicled.

The most recent application of it we have seen at work is in the winding doubling frame of Mr. Thomas Unsworth. This frame, or machine, described by the inventor as a direct-action, draw-bolt, positive stop-motion, winding doubling frame contains many improvements upon those ordinarily in use, and a description, therefore, will probably not be unacceptable.

This machine, with the necessary slight modifications for different materials, is adapted for working any description of fiber—silk, cotton, wool, flax, jute, or hemp, and these in every degree of fineness. Any desired number of threads can be wound upon one bobbin, according to the construction. The general range is from five to twenty. Across the length of the framework of the machine extends a shaft fitted with friction drums, and on the exterior of the frame, carrying also the driving pulleys. Each of these drums has two similar ones—one on each side of the frame—so adjusted as to be driven by the friction of the one first-mentioned. The bobbin for the reception of the yarn rests upon and is driven by the second drum. Over the bobbin is arranged a porcelain pressure bowl. Underneath the second drum, and hollowed to fit its periphery, there is a brake fixed, into which, by the action of the stop-needle, the drum is made to fall. This drum is fitted upon a lever, which extends towards the front of the machine, where it meets and rests upon the draw-bolt, a bar covered with a spiral spring to hold it in position. This bolt sustains it at the requisite elevation to hold it in contact with the driver drum. On the opposite extremity of the draw-bolt there is affixed at right angles a bar, and the two portions combined resolve the draw bolt into the form of the letter T, laid horizontally with the cross-piece outwards. The use of this will be seen further on. The next parts we approach are a number of oblong frames affixed near the front of the machine, as seen in the engraving, each having a division lengthwise through the middle. In these frames are inserted the direct action stop-needles, from which the machine mainly derives its name. They are composed of two parts, looped together. On the upper part there is a curl through which the threads pass; by means of the next feature. This is a heavy porcelain pressure bowl, which being brought down upon the bobbin maintains a perfectly even surface, upon which the successive layers of yarn are wound. This is of great importance, as an uneven surface leads to an unequal draught of yarn, and in the subsequent processes of twining, etc., becomes apparent in "corkscrew" threads and other defects.—*Textile Manufacturer.*



UNSWORTH'S WINDING DOUBLING MACHINE.

the lower part, pendent by the loop from the upper, drops its extremity on the inner side of the T-shaped draw-bolt, and the outer of the reciprocating bar. On the middle of the motor shaft there is a small cog wheel, geared into another on a small shaft below, the latter of which contains two eccentrics, each driving a connecting rod working a reciprocating bar extending the length of the machine. This bar has attachments passing behind the oblong frames containing the needles, and which by the action of the eccentrics are kept in constant oscillation.

We have now described the different parts of the machine, and, by the aid of the illustration, our readers will be able to follow a detailed description of its working, wherein its merits will be more readily seen. The skewered cups, or bobbins, having been placed in their position in the frame, the threads are conducted upwards, passed through the first eyelets, thence over a glass rod, through the curls of the stop-needles, and around the revolving porcelain bowl of the yarn guide, whence it is delivered upon the bobbin. The action of the machine is as follows: On the breakage of a thread, the needle, suspended at a certain elevation by its tension, instantly falls, and its lower extremity drops between the oscillating rod and the head of the T-shaped draw-bolt. Its protrusion into this position offers an obstacle to the passage of the oscillating rod, which strikes it against the draw-bolt, propelling the latter forward a sufficient extent to release the end of the lever containing or supporting the second friction drum, which instantly drops into the half round brake, stopping the revolution of the bobbin immediately, and without subjecting the yarn to the slightest friction whatever. The plates or wedges usually employed to separate the friction roller and the bobbin are thus entirely dispensed with, to the advantage of the yarn. This brake is the first distinguishing feature of the machine, but by no means the only one. The suspension of the step-needles on the threads has the effect of producing a uniform tension upon them; any momentary slack being taken up by their depression. This object is secured in a further degree by the yarn passing around a revolving porcelain bowl, fixed upon the traverse rod, where, as before observed, it is delivered upon the bobbin in an even tape-line band, composed of the whole of the threads for one bobbin. The effect sought to be obtained by these arrangements is perfectly accomplished and completed.

ON DYEING FELT.

THE fact of felt being frequently made of mixed fur and hair gives rise to considerable difficulty in dyeing. This subject has been treated fully by M. Victor Preston, in the *Centralblatt für die Textil-industrie*. He says that care must be taken that the mordants are not too energetic, or the felt will lose its natural brilliancy and strength, and the dye-vat must be kept at a moderate heat or the colors will suffer.

For reds, felt is dyed by cochineal and Brazil-wood, but the former gives a better color. The mode of obtaining the different red tones is as follows:—A tin vessel is filled with pure water, and a solution of tin being added, the whole is brought to the boiling point. The felt is then worked in it for half-an hour, and being withdrawn, a proportionate quantity of cochineal is added in fine powder, with rather less flavine; the mixture is allowed to boil some time, when the felt is again worked in it while boiling gently, and afterwards washed. A fine scarlet tint is thus produced, especially if the felt has been thoroughly cleansed, with the expenditure of but little labor and fuel. In the absence of a tin vessel a copper may be used, but with a basket lining.

For cherry-red the felt is boiled gently for two hours in a solution of tartar crystals, tin, and sulphuric acid, and finished in the cochineal bath.

Rose color is obtained by means of the bath used for cherry-red, with a little more or less tartar, tin solution, or cochineal added, according to the tint required for the finishing. A good rose color is also obtained by means of alum and tartar crystals of the best quality, and ammoniacal cochineal. It must be understood, that to succeed with any of the before-mentioned colors the felt must be perfectly washed and bleached.

For the light tints of yellow, red, fire, garnet, orange, and gold colors, the bath used for the scarlet and cherry colors may be used, with the addition of a small quantity of fustic and cochineal mixed with a solution of tin. These colors are, however, rarely applied to felt.

The tints produced with Brazil wood are very bright, but it is seldom used for felt on account of its want of solidity. To obtain dark red with this wood it is boiled with alum, which must be free of iron, and a little sulphate of copper; the felt is then rinsed and worked in a decoction of the best kind of Brazil wood. Fuchsine is also often used in the same manner as for woolen yarns.

Blue dye should be particularly good to be applied to felt, it is produced by means of cyanide of potash and aniline blue. Salts of tin, oxalic acid, and red cyanide of potassium are put in a beck of pure water, to which a small quantity of sulphuric acid is added. The felt is plunged in the dye, and energetically worked; it becomes first of a light blue color, which darkens, then turns to light blue, which soon grows darker, and when this occurs the felt must not be touched again. During the last period of dyeing, which lasts about an hour, the temperature must be raised gradually. As soon as the dark blue color appears the bath is made to boil, and is kept boiling gently for another hour uninterruptedly.

A little fuchsine or methylic violet may be mixed with the water according to the tint desired. Felt is dyed with aniline blue precisely in the same manner as wool.

Indigo carmine is rarely used for felt; when it is, it is boiled with alum and tartar, and kept boiling for a quarter of an hour; dye afterwards with the same bath successive additions of the indigo carmine in solution.

It is more easy to dye felt green than blue, and all other colors may be obtained perfectly by the following methods: Green by means of indigo, carmine or cyanide of potash, treated as above-mentioned with alum and tartar; when the felt is taken out a little flavine is added, then boil about an hour. The flavine may be replaced by a decoction of quercitron, fustic, or dyer's weed. All the tones of green may be obtained also by adding a proportionate amount of indigo-carmine or yellow coloring matter to the dye. To produce green with the cyanide of potash, the felt is first dyed blue, as above; it is then rinsed and plunged into nitrate of lead and tartaric acid, and boiled for two hours. The dyeing is then finished in a new bath consisting of red chromate of potash and a rather smaller quantity of nitric acid, which is kept over a strong fire until the color of the product has attained the desired tint. Of course the proportion of chromate depends on the intensity of the desired green.

Browns may be produced in various ways, but the red and yellow woods of santal and Brazil, nut-galls, and sumac are the materials mostly used. For fawns the felt is boiled in a bath containing santal wood and yellow wood, in the proportion of three of the former to two of the latter. The darkest colors are obtained by adding a weak solution of sulphate of iron; the felt should remain fifteen to twenty minutes in the solution. The darkest brown, and even black, are obtained by varying the proportions of the santal and yellow wood. It is unusual to have to boil the felt before dyeing, but it is sometimes necessary for reddish browns. In that case a solution of alum, with tartar and sulphate of copper in smaller proportions, should be prepared, to which should be added a decoction of yellow wood, and the felt boiled in it gently for two hours. The dyeing is completed with red or Brazil wood, according to that required. The employment of chromate of potash also presents advantages for dyeing felt brown. The felt is boiled gently in a solution of this salt, with an addition of tartar and sulphuric acid, and the operation is terminated in a new bath containing yellow wood, red wood, and Brazil wood. Chromate of potash alone gives fine red woods, which are finished with santal wood.

Yellows present no difficulty. They are dyed with a mixture of alum and tartar, added to a tin solution, rinsed, and then finished in a bath containing flavine. Another yellow is produced with a bath composed of alum, solution of tin, and decoction of yellow wood, but the tint obtained is rather too light.

The fashionable tints are rarely applied to felts, for which the natural tones are better adapted; they are, however, sometimes demanded for felt intended to be printed, and the following are the methods mostly adopted:

Silver gray tones are produced by means of a solution of tartar, nut-galls, and indigo-carmine, in which the felt is boiled for about half an hour, then the tint is deepened with sulphate of iron; by increasing the proportions of the latter salt and of the nut-galls ordinary grays are produced; for yellow and red grays it is sufficient to add a little yellow wood, or orchil violet.

Fine black is more difficult to obtain. The best results we have obtained for many years with the following receipt: Fill a copper with pure water, and make it boil, then add 1 kilogramme of carbonate of potash, 750 grammes of red tartar, 150 grammes sulphuric acid. When the liquid has well boiled, the felt, about 12½ kilogs. in weight, is passed through it by means of a wooden winch fixed above the copper, for about two hours, the liquid being kept gently boiling; the felt is then taken out, allowed to cool, and drained for twenty-four hours; then rinse it in a washing-machine, and finally finish the dyeing in a decoction of six kilogrammes of Brazil wood. The color given to felt by the above process does not fade, and resists very well the effects of air and acids, which change it but very little.

ARLONINE BLACK DIRECT ON WOOL.

THE *Teinturier Pratique*, of Tournai, says that *arlonine*, which, we may mention, is to be had at its own office, is the greatest novelty in the dyeing world, for the first time it renders possible the dyeing of wool black in a single bath, and the color is solid and unaffected by sun or air. Lastly, the new dye is cheaper than the old.

Arlonine is *hémétine* transformed into black dye before being used. It is diluted with a little water, and introduced into the beck prepared for dyeing, and heated to about 80 deg. C.; oxalic acid is then added to the extent of 5 per cent weight of the wool and ½ per cent of sulphuric acid; the whole, when stirred, should assume a yellowish tint. When the material to be dried is introduced it is worked for about ten minutes without the temperature being raised, after which the heat is increased to boiling point, and kept at that for about an hour and a half, when, if the liquor assumes a greenish, blackish, or bluish tinge, a little more acid must be added, but with great precaution, for any excess is ruinous. A few soda crystals are then added, dissolved in water, little by little, until the dye has assumed a bluish tint, when the wool is worked again for a good half hour at a temperature just below boiling point, when the black will assume a full and bright appearance; the wool is then rinsed, and the color obtained is fast and solid.

For black-black, charcoal-black, etc., for the tints of cloths, merinos, etc., a little turmeric, or, still better, sumac.

The proportions are given as follows: For the first dyeing, say 100 kilogrammes of wool—

80 to 90 kilogrammes of arlonine,
4 to 5 " of oxalic acid,
1 kilogramme of sulphuric acid,
2 " of turmeric, or
5 " of sumac.

The bath keeps, and future workings require less color and less mordant. For second 100 kilogrammes take—

60 to 70 kilogrammes of arlonine,
2 50 to 3 " of oxalic acid,
750 grammes sulphuric acid.

For a third working the proportions may be still further diminished. The cost of arlonine is 35 francs per 100 kilogrammes.

For a single working, or for small quantities, this new dye is not economical, but it is claimed for it that the black is finer, less greenish, and less reddish, than obtained by the old methods.

SOLUBLE ANILINE BLACK AND GRAYS.

A METHOD of obtaining a soluble aniline black, the invention of M. Collin, has created some interest, and it has been put to the test by M. R. Granzmann, at the instance of the Industrial Society of Rouen, in order to ascertain its applicability to cotton. The result is not satisfactory as regards black, but is otherwise interesting. The product was stated to be the result of the oxidation of aniline by nitrobenzine in presence of an organic acid. The difficulty is to avoid carbonization. The so-called soluble black was found to contain 3 per cent of iron, in the form of protoxide, and a certain portion of sulphur. The black is in gray, crystalline grains, and cold water will dissolve 155 to 160 grammes per litre. Glycerine also is a good solvent, but neither mineral acids nor alkalies. With respect to mordants, M. Granzmann gives the following list: Sulphuric and other acids, the acetates of alumina and lime, nitrate of iron, etc., produce an abundant black precipitate; while sulphate of iron, copper, or zinc, acetate of lead, or chloride of tin, produce a dark blue precipitate; no precipitate is produced by acetic

acid, nitrate of alumina, bichromate of potash, the prussiates, etc. It was found very difficult to find a good combination for printing. When the coloring matter was applied directly either in the printing or dyeing of tissues, M. Granzmann was surprised at first at the little intensity obtained with the new matter, and the obtaining a positive black was given up as hopeless; but the color dyed cotton without a mordant, but in a bath pretty concentrated and heated gradually, a reddish-gray color was produced, of a certain intensity, which could not be exceeded; the iron, alum, chrome, and lead mordants would not act with it; and the best mode of dyeing cotton in hanks, or placing fabrics with it, was found to be to pass the material through a bath of the strength desired, and then to fix it by means of a solution of sulphate of copper, acetate of lead, etc., for a bluish tint, or nitrate of iron for a darker tint. The effect is improved by drying between the two operations. Thus fine dark grays are obtained, but black never. These grays bear washing and the effect of light fairly, but they will not bear soaping, and are destroyed quickly by chloride of lime. The reporter says that the tints thus produced are agreeable in effect and easy to dye, but the price of the coloring matter is rather high—16 to 18 francs per kilogramme, and that, although the object in view—a positive black—has not yet been obtained, M. Collin is working in the right direction.

TISSUES, especially woolen, which have been for a long time exposed to air and light, acquire a stronger affinity for coloring matters than portions of the same material which have been kept in the dark. This circumstance often renders the production of a level shade in garment dyeing simply impossible, those parts upon which the light has chiefly fallen always taking the dye more readily, and coming up as dark stripes or spots.

SAVARY'S MORDANT.—The "produit-Savary" is a patented mordant employed in dyeing wool blue-black, green, and maroon. It is composed of alum, tartar, bichromate, and indigo-carmine, the proportions varying with the tint required. It forms a paste, which solidifies. It gives blue-black with logwood, green with fustic, and maroon with santal or caliatur. The patentee claims the bichromate as his chief element.—*Moniteur de la Teinture.*

DYED YARN RICK CLOTHS.—MM. Chapon frères recommend that the cloths made for awnings, and other like purposes, which soon become shabby looking without being really worn, should be made of dyed instead of unbleached yarn, in which case the dressing will remain uncolored, leaving the appearance of the cloth quite unchanged, and prevent the gradual discoloration, without diminishing the inherent qualities of the dressing itself. They specially recommend catechu for the dye, on account of its solid color and conservative qualities.

BROWN COLORS WITH WOOD EXTRACTS.

M. A. B. JENSON gives the following practical recipes for a class of colors which fill an important place in printing of ordinary cotton goods, and especially in those cases in which madder browns are too dear. For ground color for printing varied hues upon as dyes, these colors offer great advantages in printing, and with respect to the appearance of the tissue, but which, curiously enough, says M. Jenson, only find favor in the eyes of German consumers. The following methods are given:

Bleached cotton goods submitted to the action of alum and pyroligneous acid at 8° to 9° Baumé, are foularded three times, and then hooked on perches and carefully stove dried. When the drying, which requires great attention, is completed, the cloth must be exposed in a more airy position, in order that the salt may be rendered more alkaline by the evaporation of the acid; it is then printed by the well-known process with caustic lye. When printed, the cloth is left hanging all night on the perches, then in a bath of two dungings, and finally fully washed in running water.

In printing, in order to produce a dark brown ground quite uniform in tone, two baths are required, of which the first is composed as follows: 60 litres of solution of 3 kilogrammes of extract of Brazil wood; 80 litres of decoction of 40 kilogs. of redwood; 24 litres of decoction of 4 kilogs. of quercitron; 2 kilogs. of glue dissolved in water.

The cloth is worked for an hour in this bath at 70° R., and then rinsed in water. The second bath is given by M. Jenson in precisely the same terms as the first, and, although we suspect an error, we cannot point it out.

The cotton fabrics being plunged in the second bath, which is gradually heated for an hour and a half, and, after the dyeing is finished, they are left for an hour in running water, and are finally washed as many times as necessary, till the water is left perfectly clear, when the cloth is pressed and dried.

For lighter brown grounds for white impression, without any varied tints in the pattern, only 48 litres of solution of 2 kilogs. of Brazil wood are employed in the first bath, and only 50 litres of solution of 3 kilogs. of extract of the second.

For brown grounds to be decorated in various tints, the same steam colors may be used as for black grounds, only after the steaming some reddish tones must be added, of which the composition is given below:

FOR DEEP RED.

Eight litres of decoction of red wood at 4° B., thickened with 2 kilogrammes of finally powdered gum; the mixture being allowed to cool a little, add

1 kilog. of ammoniacal chloride of tin.

125 grammes of acid of sugar. When the mixture is quite cold, refresh it with 650 grammes of solution of tin.

LIGHT RED.

This tint is obtained in the same manner as the preceding, but reducing the concentration of the decoction of red wood from 4° B. to 2° B.

Light red may very well be printed on dark red.

NEW DRESSING FOR TISSUES.

THIS invention by James Short, manager of the carpet works at New Jersey, N. J., has attracted great attention in France. We extract the following from our contemporary, the *Moniteur des Fils et Tissues:*

The new dressing is applicable to all tissues which have not been deprived of dressing in order to facilitate weaving, but more especially to long pile carpets. The carpets, after leaving the dressing machine, are steamed at a low pressure, so that the steam penetrates every part of the fabric, which, being thus damped throughout, and at the same time stretched, the dressing in the threads becomes softened, and finally drying, the desired consistency is obtained without the addition of any of the substances generally employed for the purpose. It is said that by this treatment the threads are so completely united together that a much smaller proportion of jute is required than usual to give the requisite stoutness; moreover, the steam raises the pile completely and regularly, and gives the carpet a peculiarly velvety surface. The inventor says also that the steaming removes all smell, and fixes any chalk that may have been used to give brilliancy to the whites.

[ST. LOUIS REPUBLICAN.]

GEOLOGY OF THE WEST.

By J. VAN CLEVE PHILLIPS.

IN boring the artesian well at the Insane Asylum, St. Louis, the auger penetrated 3,800 feet, going through 200 feet of coal measures, 500 feet of sub carboniferous limestone, 1,600 feet of Devonian, and 2,000 feet of upper and lower silurian, and in the bottom cut a brown ferruginous sandstone, supposed to be of Potsdam age.

This sandstone carries the fossil of a marine animal known as a trilobite, and establishes the fact that at 3,500 feet in depth below the present level of the Mississippi River and the pavements walked by the busy population of St. Louis, once rolled the waves of a silurian ocean.

We will suppose this auger hole is a shaft 6 by 10 feet square from the surface to the bottom of the hole, and that we have the privilege of going down and examining the strata in its sides as they would appear from the records shown by the borings as the auger penetrated the strata.

First we pass 20 feet of alluvial brick clay, then 40 feet of pipe clay, shaley limestone, and fire clay, and at 60 feet deep find a three foot vein of coal; at 200 feet we reach the upper Archimedes limestone, the same stratum that is exposed at the top of the deep quarry on Tayon avenue, and which contains fossil fish; this is also the same age of rock as the Grafton quarry. Below this is the St. Louis limestone, and next another floor of Keokuk or Archimedes limestone, a rock filled with fossils. At 1,200 feet we reach the great salt and oil floors of the Mississippi basin. This stratum comes to-day 30 miles below on the I. M. and S. R. R., and west 30 miles on the M. P. R. R., and from a quarry south of the city that furnished the rock to build the basement of the Four Courts; and as that rock weathers, its black, mottled color is due to the bitumen which the heat of summer has brought to its surface. Chicago is built on this geological horizon, and strata in quarries west of that city are filled with bitumen and petroleum. If space would admit, we might trace this floor throughout the length and breadth of the great basin of the Mississippi, and show where it rises to-day; and has again gone down 4,000 and 5,000 feet under the coal measures of the grand prairies of Illinois and Kansas, and is formed in a great basin in Venango county, Penn., and this again subdivided in lesser basins, and where the economic laws had stored the rich floors of petroleum that have proven such a source of national wealth. But we must go downward. At 2,000 feet we have reached the Niagara group of the upper silurian series, a rock rich in fossils, and of the same age as that over which the great cataract pours its thundering falls. This rock also forms the table lands of Iowa, west of Dubuque, and is the formation of the mammiliary outlying mountains that mark such a conspicuous feature in the topography of the upper Mississippi lead fields, also forms the mound system of the great lead and zinc fields of Central Missouri. Below this we reach the "Trenton limestone," a member of the silurian system, and same age of rock as found shelving out at low water mark on the Mississippi opposite Dubuque, Iowa, and where the weathering of the slabs has exposed in an embossed form the tribe of the *arthrosteidæ*. These fossils are there seen 6 and 10 feet in length, and with their enameled scales and bucklers were the mailed warriors of the silurian seas. Below we find the lower floors of lower silurian, chest-beds, hornstone and coraline limestone, the same age of rock as that which abuts against the Iron Mountain on its west side, and is the great lead, zinc, copper, and iron-bearing rock of southeast Missouri. In passing the Archimedes floor in the subcarboniferous system, we were in the horizon of strata that carries the great lead and zinc veins of southwest Missouri. And in passing the Niagara and Trenton groups we were in the horizon of the blue shales, cap-rock, upper and lower galena and blue limestone of the upper Mississippi lead field. On reaching the bottom of our shaft we find a coarse, brown, ferruginous sandstone; and we might in the imagination follow this floor to where it rises to-day around the Iron Mountains, 100 miles south of the city, and where it dips under the great coal basins of central Illinois and Kansas, and comes to-day on the shores of Lake Pepin, Lake Superior, and covering large areas in northern Wisconsin, being the stratum that bears the great pine flora of that State, and to where it extends out from the "great basin," in a long finger through central New York.

We have now a general idea of the underground system under this city; and if we go back in the imagination to the time when the strata of the upper, middle, and lower coal series had been laid down, and the inauguration of the river systems commenced, we shall find that the coal vein of St. Louis county coal basin and the Illinois coal basin in that era lay in solid strata where the Mississippi River now flows—that the strata were elevated along the lines now followed by the river, and 300 feet of coal measures and St. Louis limestone has been abraded, and a coal vein for 10 miles wide has been cut away to form the valley through which the river now flows opposite the city.

The science of geology is based on the idea that like produces like; that the great is in the little, and *vice versa*, and that all the phenomena of the earth's surface, and its strata, and vein system have been produced by the constancy of action of natural economic laws, and that these causes are now in action. And where are we to look for the causes now in action that laid down upon the floor of an ocean the sedimentary matter to form all the strata, from the sandstone in the bottom of this artesian well to the upper coal series, say 6,000 feet vertical of strata? We shall see.

The Mississippi River carries out millions of tons of sedimentary matter daily from the washings of the banks of the hundred tributaries of the Gulf of Mexico; this sediment is there taken up by the Gulf Stream, and carried north and spread over the floor of the Atlantic, when it settles in comparatively still water under what is known as the Sargossa Sea; and if we follow up the genealogical thread or heraldry of this river system, we shall see that this process of spreading detrital matter over the ocean's floor has been going on since the river system in the "great basin" was inaugurated, and the wearing down of the valleys of the Ohio, Tennessee, Rock River, the Missouri, Arkansas, and a hundred other branches were carried forward.

At Dubuque, Iowa, 600 feet-vertical of strata has been cut away; at Pittsburg, 400; at Cincinnati, 100; from the head of the Ohio to its mouth from 100 to 500 feet. The same of the Missouri, Arkansas, St. Peter's, Cumberland, White, and hundreds of other branches. Enough sedimentary matter has gone out of the mouth of the Mississippi River, from the wearing down of the valleys of these streams and forming of the topography of the great basin of the Mississippi River, to have filled up the Gulf of Mexico and then formed an island 1,000 feet high above its present level; and this sedimentary matter has been taken up by the Gulf Stream and carried out and spread over the floor of the Atlantic Ocean, where, in comparatively still water, it has settled and formed stratified rocks; and here we now see the causes in action that at one time prevailed, and which laid down upon the ocean's floor the sedimentary matter to form the Potsdam sandstone, now bored in the bottom of this artesian well, and all the strata above to the thickness of 6,000 feet were afterward piled on to the floors of subsequent seas. The history or chronology of these strata is written in the fossils, salt and oil flows and coal plants which grew in successive floras, and were laid down and are now carbonized in mineral fuel in these great continental coal basins. The Iron Mountain lead, zinc, and copper veins belong to a later era, a comparatively recent geological epoch, as there was no necessity for the existence of these ores until men had come to have dominion on the earth and to be conditioned to utilize these metals.

When standing on the floor of Potsdam sandstone, we may safely say that in this early day of the chronology of the strata navies did not ride upon the bosom of the deep to founder and go down with all their armature of war, as would be found if Atlantic's floor should be dried land.

The fossils tell us that the nautilus and ammonite were the only sails then seen; that these early voyagers its compeer then on the waves of this silurian sea then did hail.

THE EARTH'S INTERIOR DENSITY AND CONSTRUCTION.

By D. P. BLACKSTONE.

As the law that causes the *apple* to fall is the law that controls the heavenly bodies in their orbits, so the law that makes the *apple* float on water is the law that prevailed in building up the earth and the heavenly bodies.

The demonstration of the first of the above propositions was the grandest achievement of Newton's life. Astronomy since then has been developed as a science. The demonstration of the second of the above propositions is the chief thing of value in this paper. It places geology or world building in a position to be studied also as a science.

Representing the attractive force of a sphere at its surface, having mass and radius equal to the earth's mass and polar radius, by unity, then the attractive force of the earth at the poles is $\frac{250}{249}$. The formulæ from which I obtain this result are demonstrated under the heading, *The Attractive Force of the Atom in Combination*, published in SCIENTIFIC AMERICAN SUPPLEMENT No. 75. If the earth was uniformly dense from surface to center its attractive force at the poles would be $\frac{250}{231}$. The attractive force $\frac{250}{294}$ per conditions of aforementioned formulæ requires the density of the earth to increase from surface to center.

The mean specific gravity of the earth as obtained by Airy per pendulum experiments at the Harton Colliery, near Newcastle, England, in 1854, is 6.56. The average of 2,000 experiments made by Sir Francis Bailey in England in 1841–'2 with torsion balance is 5.67. The true mean specific gravity is, doubtless, somewhere between five and a half and six and a half.

It is evident, then, that the earth's interior density from surface to center must be such as to give an attractive force at the poles of $\frac{250}{249}$, and at the same time the whole mass of the earth must not fall short or exceed that requisite to give a mean specific gravity from 5.5 to 6.5. To satisfy these two conditions I made many long and tedious computations. After completing a few of these computations I deduced the law by which the earth was constructed. I then became satisfied that liquids and mineral and metallic solids are incompressible, or nearly so. This conclusion is in accordance with all experiments and observations. The compression of solid rock or iron when loaded nearly to crushing weight is too small to be measured. A certain quantity of water at 39° Fahrenheit makes a certain bulk; and the same quantity of water frozen to a solid makes a bulk only a trifle greater. Until the vulcanites can cast an enclosed iron vessel that will not burst when filled with water, and this water freezes, it is at least not scientific to say that solid ice can be compressed six or eight times.

The fact that the specific gravity of platinum and iridium, the two heaviest of known substances, is not far from 22, and also the fact that my computations per two test conditions resulted in 22 specific gravity for the center of the earth, soon enabled me to abandon what I had been for a lifetime taught by geologists about the compressibility of liquids and solids, and become a believer in the doctrine that the Great Architect, when he made his *foot-stool*, ordained that the heaviest substance should sink and the lightest swim. That the law of specific gravities would control in the arrangement of the matter in the construction of a world from liquids, is at least scientific. There is no assumption about it, as in the case of the compressibility of liquids and solids. A child has only to throw a stick and stone, or some oil or mercury, into the water, to prove it. Thus simple are the laws of the universe when viewed, not in the complexity of the ocean, but at the fountains whence the ocean springs.

When the matter, not volatile, was a melted liquid, the earth, by the system of specific gravities, was built up from its center in layers, each layer having a thickness dependent on its position and the quantity of matter of a certain specific gravity. The fact that a quantity of all known minerals and metals can be held up in combination with some one of the acid, alkaline, or other heated gases, is sufficient to account for the heavy metals now found at or near the surface of the earth. It is no wonder, then, that metals having the specific gravities and chemical affinities of platinum and gold are now rare.

There are certain well-known properties possessed by each of the minerals and metals. As the properties of matter *seemingly* did the work of construction, it is reasonable to expect harmony between the results of any correct computation showing the construction of the earth and the workings of the laws of matter. Before giving the results of my computations I will tabulate some of the properties of some of the minerals and metals, in order to trace more conveniently this harmony.

In the following table No. I., column 2 gives specific gravity; 3, heat centigrade to melt or fuse; 4, expansion or contraction for each degree centigrade; 5, conductive power; 6, specific heat, that of water being unity:

The Earth's Interior Density.

TABLE I.

	2 S. G.	3 Fuse.	4 Contraction.	5 Conduction.	6 S. H.
Iridium. ...	23.00				
Platinum ...	21.50	2000°	0.0000099	8.	0.032
Gold	19.30	1250°	0.0000147	53.	0.032
Tungsten ...	17.40				
Mercury ...	13.60	—39°			
Palladium ..	11.80			6.	
Rhodium ..	11.00				
Silver	10.50	1000°	0.0000191	100.	0.056
Bismuth....	9.80	562°		2.	0.031
Copper	8.60	1150°	0.0000172	77.	0.092
Nickel.. .	8.30				0.108
Manganese ..	8.00				
Cast iron...	7.30	1250°	0.0000124	12.	0.114
Granite.....	From 2.60 to 2.90	1200° (?)	0.0000091		
Quartz.....	2.70				
Glass.....	2.60	1030°	0.0000087		0.198
Trap rock..	From 2.42 to 2.90			0.00027	

TABLE II.

Layers.	Density.	Specific Gravity.
1	1.	2.75
2	2.75	7.56
3	4.50	12.38
4	6.25	17.19
5	8.	22.00

The earth being taken in five equal layers, counting from surface, having density and specific gravity, as given in table II., gives per computation $\frac{1}{2}\frac{1}{5}\frac{1}{6}$ for attractive force at poles and mean specific gravity 6.5. This is the result, doubtless, very near the truth.

Taken in ten layers, equal in thickness, having density of surface layer 1, and center layer 8, and intermediates varying by a common difference $\frac{1}{7}$, gives attractive force at poles $\frac{1}{2}\frac{1}{1}\frac{1}{7}$, and mean specific gravity 7.1. Twenty layers under conditions, as above, gives results still farther from true.

Taken in five layers, equal thickness, having density of surface 1, and center 10, and intermediates, varying by a common difference $2\frac{1}{2}$, gives attractive force at poles $\frac{1}{3}\frac{1}{0}\frac{1}{3}$, and mean specific gravity 7.7.

Taken in ten layers, having density of surface and center 1 and 10, and intermediates 2, 3, 4, etc., gives attractive force at poles $\frac{1}{2}\frac{1}{8}\frac{1}{9}$, and mean specific gravity 8.3.

Per law of the results of computations, it is evident—

1. That the earth cannot be taken with an infinite number of layers increasing in density from surface, and satisfy the test conditions of polar attractive force, and mean specific gravity, and existing surface specific gravity. Such, however, should be true, if greater density toward the center were caused by compression.

2. The conditions of polar attractive force, mean specific gravity, and existing surface specific gravity are satisfied by assuming the interior of the earth, for a radius distance from the center of about 3,200 miles, composed of layers of metals, arranged per law of specific gravities, and a surface layer about 800 miles in thickness, composed of granite or primitive rock, having an average specific gravity of about 2.75.

In the computations I considered the metallic layers in group, and the specific gravity there used for a layer is the average of a group.

The second inference conflicts with no law of matter. That there is a rock layer from 800 to 1,000 miles in thickness, the results of experiments, and mathematical demonstrations that I know to be true, clearly prove. Not far below the rock is the great iron or electro-magnetic layer that chiefly controls the magnetic needle in all parts of the earth. Surface deposits, of course, have their influence.

Before putting the key-stone into the edifice of the investigation, it is necessary to trace a part of the outline history of the earth from the period when that portion of matter now below the stratified rock was a boiling liquid. All matter, then, metallic or otherwise, volatile at a temperature at least 1000° centigrade, was in a red-hot aerial form. At this time the thick burning mist concealed the sun from the liquid surface, and the earth was its own luminary. So it had been since it took on the form of a globe. The metallic layers were of a temperature nearly uniform, for the metals are good conductors. Besides, in liquids, heat travels by boiling or convection. The average of the metals is a conductor more than one hundred thousand times better than trap or primitive rock. The rock layer, therefore, was a bad conductor, but while in a liquid state, like water, it conveyed heat by convection. As water boiling in a kettle does not cease to boil till the heat at the bottom becomes less than boiling heat, so the primitive rock layer did not commence to solidify until the temperature of the metallic layers became that essential to solidify the rock. That day the tides and storms were on the face of the boiling deep. As fast as the *forty miles* crust formed it broke up; and, by increased specific gravity from contraction, it fell to the metals. Thus the earth became a solid on a foundation so solid that neither tides nor boiling storms could move. The balance of the heat then became enclosed in an encasement of almost non-conducting rock. The rain that then fell was mineral and metallic.

The next day dawned on the earth a red-hot solid, having an average temperature from 1000° to 1200° centigrade. The cooling and contraction commenced. It was more rapid at the surface than in the interior. The first effect then was checks and cracks in the surface of the rock, which hastened the process of cooling at a greater depth. The condition of primitive rock or granite is one nine-millionth for each degree centigrade, and the average for the metals is about one sixteen-millionth. This difference in the process of shrinkage caused a vacancy between the rock and the metals. The rock layer then in large areas in various localities fell down on the metals. The remaining portions of the layer breaking and tilting up in the operation of settling and squeezing in, furnished the extra material to commence the foundations of the continents. The great valleys that then had their beginning are now the beds of the oceans. The process of contraction, and thus deepening the valleys and building up the continents, continued as the interior heat escaped. As the temperature of the aerial regions fell, the storms of mineral and metallic rain went on. In the order of volatility the lead, the tin, the sulphur, the iodine, the sodium, the potassium, the chlorine, and so on, came down. Finally, when the water fell, there became a working laboratory, the like of which never before or since was seen on the face of the earth. The chemicals, ravenous to find affinities, devoured the surface metals and disintegrated primitive rock. As the water percolated through the crevices into the cavities and large caverns, earthquakes and volcanoes began. The tremendous chemical action of this period considerably changed the face of the earth. As the shrinkage went on, the land lifted itself above the sea, and the building of stratified rocks commenced. The stratified rocks then began to drink up the impurities of the water and the air. In due time suitable conditions for certain vegetable and animal life came; then this vegetable and animal life came also, and became embedded in the stratified rocks. During this period the great vegetable growth and the infinite number of shell and coral builders devoured largely the carbon and the calcium in the air and the water. With the cooling of the atmosphere the water clouds for a few moments cleared away from a portion of the sky; then the sun for the first time shone on the inhabitants of the earth. The swimming fish then appeared in the sea, the flying fowl in the air, and the serpent first began to enjoy paradise in his garden of Eden.

For the details of this geologic history I refer the reader to the stratified rocks, or some good treatise on the same. As I have seemingly endorsed the theory that matter built up the world and peopled it, I have a word to say additionally before I leave this branch of the subject.

If matter has the competency to evolve an infinite number of worlds and cause them to move in harmony through space, and also to people these worlds with self-moving, thinking, rational, conscious life, then, in accordance with our experience, it is common sense to say that matter is a self-moving, thinking, rational, omnipotent existence, or some thinking, rational, omnipotent existence endowed inert matter under law with the power to do these wonderful things. The human brain is the highest order of matter we know anything about. Man now controls the whole animal kingdom; he makes the winds and the waters subserve his purposes. Such work can only be done by intellectual power. Man is not a chance production. Either a controlling mind or matter had man in view long before he appeared on earth. The history of the back-bone animal from its beginning points forward to man. Way back in enigmatical history, when the serpent and father Adam and mother Eve were called up to the bar of justice, the judgment there rendered that one of the back-bone race should hold its existing type and continue irresponsible, and that two should develop, become responsible and god-like in intellectual powers, is not contradicted by geologic science. For the story of the three snakes I refer the reader to Darwin and Huxley. The moral of the snake story can be clearly read from the fossils imbedded in the strata of the human mind. To deny the moral story is to deny one's own consciousness.

The average shrinkage per degree centigrade between the average of the metals and granite is about one seven-millionth. For 1,000° this amounts to $\frac{1}{7}\frac{1}{0}$ nearly. Taking the thickness of the metallic layers to be 3,200 miles, the difference between the shrinkage of the metallic and the rock layer for 1,000° would leave a space under the rock layer of a little more than 22 miles. It is evident where is now the deepest part of the sea that there is the place on the rock layer which first settled and continued to settle without receiving additional thickness. Prof. Dana says in substance on this point that the continents have always been of the same shape as now; that they have been the most elevated portions of the crust, and the oceanic basins have always been the most depressed.

The difference then between the solidity of a spherical shell 800 miles in thickness, having an outside radius 4,000 miles and a spherical shell also 800 miles in thickness having an outside radius 4,000—22 or 3,978 miles, should be sufficient to build up the solid part of the earth outside of a sphere having a radius from the bottom of the deepest sea to the center of the earth. Per computation I find this difference sufficient to build about 8 miles in thickness over the whole surface of the earth. A sounding has been made in the Indian Ocean to the depth of 8 miles. The rapidity at which the tides travel over some parts of the sea requires a depth of more than 10 miles. On principle of equilibrium, not considering volcanic action, if the sea covered over one-half of the surface of the earth, it would be reasonable to expect the sea bed a counterpart of the land surface, and the depth of the deepest sea to equal the height of the highest mountain. The land surface is to the sea surface as 7 to 18 nearly. It is, therefore, not unreasonable to take the height of the highest mountain to the depth of the deepest sea in the same proportion. The average height of the plateau of Thibet in Asia, containing several hundred thousand square miles, is nearly 3 miles above the level of the sea. The mountain range around Thibet is the highest in the world. The height of this range, not thrown up by volcanic action, cannot exceed 4 miles. This makes the depth of the deepest sea a little over 10 miles. The average depth of the sea is about 3 miles. This taken from 10 miles leaves 7 miles. The average height of the land above the sea added to 3 miles in depth under the continents and spread over the whole surface of the earth would build up about 1 mile. This added to the 7 miles makes the 8 miles required nearly.

The chemical action that causes the earthquakes and volcanoes in cavities and caverns is doubtless quietly eating the rocks to several miles in depth, all over the surface of the earth. This causes the increase in temperature, as found in the mines and in the boring made in the earth. From this cause an average temperature of from 100° to 200° centigrade may be held in the interior of the earth. The earth has been slowly contracting during the past 3,000 years. Thus the marks on the sea shore show.

The mathematicians who have made computations for the precession of the equinoxes say that precession cannot be accounted for unless the earth is solid, at least to the depth of 1,000 miles.

The position of the land and the sea, as shown by a view of the map of the world, inclines a mathematician to believe that the settling down and the building up of the rock layer is sufficient to account for the angle of the plane of the ecliptic to the plane of the equator.

When the earth was in a gaseous form and extended in radius to the moon, the ratio of surface density to center density was much greater than at present. The change in this ratio resulting from liquidizing and solidifying the gases in the reduction of the earth to its present size is one of the causes why the earth now rotates too slow on its axis to account for the evolution of the moon. The other cause is the cause that made Jupiter the largest planet of the solar system and produced the asteroids, a demonstration of which is too long and complicated to be added to this paper.

HEAT UNDERGROUND.

SOME of the drifts on the lower levels of several of the Comstock mines are found to be so hot that it is next to impossible for the men to work in them. When they can work it is to great disadvantage, and considerable labor and money is expended by the companies to supply fresh air. In some cases men can only work a few minutes and then run out to cool off. In the Consolidated Virginia mine, the face of the north drift on the 1750-foot level from the Gould & Curry, near the east wall of the ore vein, is so hot that it is necessary to keep a close, tight box, or cooling room, in close proximity to the workmen, in which the temperature of the air is kept down by compressed air, so that the men may cool off and change every few minutes. Another of these cooling boxes has to be placed at a half-way point in the drift for the use of the men who run the cars in and out.

The Savage incline, also, at a point near the water, is so hot as to be almost beyond human endurance. But for their shirts the skins of the men would be blistered as though by a jet of scalding steam. A man from the mine showed an *Enterprise* reporter a blister on his arm that was nearly as large as a man's hand. This blister was caused by exposing his arm at the bottom of the incline. It is so hot down at the water that, on screwing a nut on the end of a bolt, one man would be able to do no more than fasten a monkey-wrench upon it before he would have to retreat. Another would then descend and give the wrench two or three turns. One day last week the giraffe got off the track well down the incline, and in trying to replace it one of a small party of men was so overcome by the heat that he fell down in a state of insensibility. His companions carried him from a point between the 1700 and the 1900-foot levels to the 1300-foot level of the Hale and Norcross mine, where he could obtain a mouthful of fresh air. He was still unconscious when he reached the point named. The Hale and Norcross mine is now quite cool, the draft in it having again changed, being once more down the main shaft.

PROFESSOR TYNDALL ON SPONTANEOUS GENERATION.[1]

THE investigation embodied in the memoir now submitted to the Society was opened in the summer of 1876 by a series of tentative experiments on turnip infusions, to which were added varying quantities of bruised or pounded cheese. I was soon, however, drawn away from them to other experiments on infusions of hay. With this substance no difficulty was encountered in my first inquiry. Boiled for five minutes, and exposed to air purified spontaneously or freed from its floating matter by calcination or filtration, hay infusion, though employed in multiplied experiments at various times, never showed the least competence to kindle into life. After months of transparency, I have, in a great number of cases, inoculated this infusion with the smallest specks of animal and vegetable liquids containing *Bacteria*, and observed, 24 hours afterwards, its color lightened, and its mass rendered opaque by the multiplication of these organisms.

But in the autumn of 1876, the substance with which I had experienced so easily and successfully a year previously, appeared to have changed its nature. The infusions extracted from it bore in some cases not only 5 minutes' but 15 minutes' boiling with impunity. But on changing the hay a different result was often obtained. Many of the infusions extracted from samples of hay purchased in the autumn of 1876, behaved exactly like those extracted from the hay of 1875, being completely sterilized by five minutes' boiling.

To solve these discrepancies, numerous and laborious experiments were executed with hay derived from different localities, and by this means, in the earlier days of the inquiry, it was revealed that the infusions which manifested this previously unobserved resistance to sterilization were, one and all, extracted from old hay, while the readily sterilized infusions were extracted from new hay, the germs adhering to which had not been subjected to long-continued desiccation.

I then fell back upon infusions whose deportment had been previously familiar to me, and in the sterilization of which I had never experienced any difficulty. Fish, flesh, and vegetables were resubjected to trial. Though the precautions taken to avoid contamination were far more stringent than those observed in my first inquiry, and though the interval of boiling was sometimes tripled in duration, these infusions, in almost every instance, broke down. Spontaneously purified air, filtered air, and calcined air—calcined, I may add, with far greater severity than was found necessary a year previous—failed in almost all cases to protect the infusions from putrefaction.

I had the most implicit confidence in the correctness of my earlier experiments; indeed, incorrectness would have led to consequences exactly opposite to those arrived at. Errors of manipulation would have filled my tubes and flasks with organisms instead of leaving them transparent and void of life. By the unsuccessful experiments above referred to, a clear issue was therefore raised. Either the infusions of fish, flesh, and vegetable had become endowed in 1876 with an inherent generative energy which they did not possess in 1875, or some new contagium external to the infusions, and of a far more obstinate character than that of 1875, had been brought to bear upon them. The scientific mind will not halt in its decision between these two alternatives.

For my own part the gradual but irresistible interaction of thought and experiment rendered it at first probable, and at last certain that the atmosphere in which I worked had become so virulently infective as to render utterly impotent precautions against contamination and modes of sterilization, which had been found uniformly successful in a less contagious air. I therefore removed from the laboratory, first to the top, and afterwards to the basement of the Royal Institution, but found that even here, in a multitude of cases, failure was predominant, if not uniform. This hard discipline of defeat was needed to render me acquainted with all the possibilities of infection involved in the construction of my chambers and the treatment of my infusions.

[1] "Further Researches on the Deportment and Vital Resistance of Putrefactive and Infective Organisms, from a Physical Point of View." By John Tyndall, LL.D., F.R.S., Professor of Natural Philosophy in the Royal Institution.—Abstract.

I finally resolved to break away from the Royal Institution, and to seek at a distance from it a less infective atmosphere. In Kew Gardens, thanks to our President, the requisite conditions were found. I chose for exposure in the Jodrell laboratory the special infusions which had proved most intractable in the laboratory of the Royal Institution. The result was that liquids which in Albemarle Street resisted 200 minutes' boiling, becoming fruitful afterwards, were utterly sterilized by 5 minutes' boiling at Kew.

A second clear issue is thus placed before the Royal Society. Either the infusions had lost in Kew Gardens an inherent generative energy which they possessed in our laboratory, or the remarkable instances of life development, after long-continued boiling, observed in the laboratory are to be referred to the contagium of its air.

With a view to making nearer home experiments similar to those executed at Kew, I had a shed erected on the roof of the Royal Institution. In this shed infusions were prepared and introduced into new chambers of burnished tin, which had never been permitted to enter our laboratory. After their introduction the liquids were boiled for 5 minutes in an oil-bath.

The first experiment in this shed resulted in complete failure, the air of the shed proving to be sensibly as infective as the air of the laboratory.

Either of two causes, or both of them combined, might, from my point of view, have produced this result. First, a flue from the laboratory was in free communication with the atmosphere not far from the shed; secondly, and this was the real cause of the infection, my assistants in preparing the infusions had freely passed from the laboratory to the shed. They had thus carried the contagium by a mode of transfer known to every physician.

The infected shed was disinfected; the infusions were again prepared, and care was taken, by the use of proper clothes, to avoid the former causes of contamination. The result was similar to that obtained at Kew, viz., organic liquids, which in the laboratory withstood 200 minutes' boiling, were rendered permanently barren by 5 minutes' boiling in the shed.

A third clear issue is thus placed before us, which I should hardly think of formulating before the Royal Society, were it not for the incredible confusion which apparently besets this subject in the public mind. A rod 30 feet in length would stretch from the infusions in the shed to the same infusions in the laboratory. At one end of this rod the infusions were sterilized by 5 minutes' boiling, at the other end they withstood 200 minutes' boiling. As before, the choice rests between two inferences. Either we infer that at one end of the rod animal and vegetable infusions possess a generative power, which at the other end they do not possess; or we are driven to the conclusion that at the one end of the rod we have infected, and at the other end disinfected air.

The second inference is that which will be accepted by the scientific mind. To what, then, is the inferred difference at the two ends of the rod to be ascribed? In one obvious particular the laboratory this year differed from that in which my first experiments were made. On its floor were various bundles of old and desiccated hay, from which, when stirred, clouds of fine dust ascended into the atmosphere. This dust proved to be both fruitful and in the highest degree resistant. Prior to the introduction of the hay which produced the dust, no difficulty as regards sterilization had ever been experienced; subsequent to its introduction my difficulties and defeats began

In these and numerous other experiments a method was followed which had been substantially employed by Spallanzani and Needham, and more recently by Wyman and Roberts, the method having been greatly refined by the philosopher last named. The flasks containing the infusions were only partially filled, the portions unoccupied by the liquids being taken up with ordinary unfiltered air. Now as regards the death point of contagia, we know that in air it is higher than in water, the self-same temperature being fatal in the latter and sensibly harmless in the former. Hence my doubt whether, in my recent experiments, the resistance of the contagium did not arise from the fact that it was surrounded, not by water but by air.

I changed the method, and made a long series of experiments with filtered air. They were almost as unsuccessful as those made with ordinary air.

One source of discomfort clung persistently to my mind throughout these experiments. I was by no means certain that the observed development of life was not due to germs entangled in the film of liquid adherent to the necks and higher interior surfaces of the bulbs. This film might have dried, and its germs, surrounded by air and vapor, instead of by water, might on this account have been able to withstand an ordeal to which they would have succumbed if submerged.

A plan was, therefore, resorted to by which the infusions were driven by atmospheric pressure through lateral channels issuing from the centers of the bulbs. As before, each bulb was filled with one-third of an atmosphere of filtered air, and afterwards heated nearly to redness. When fully charged, the infusion rose higher than the central orifice, and no portion of the internal surface was wetted save that against which the liquid permanently rested. The lateral channel was then closed with a lamp without an instant's contact being permitted to occur between any part of the infusion and the external air. It was thus rendered absolutely certain that the contagia exposed subsequently to the action of heat were to be sought, neither in the superjacent air nor on the interior surfaces of the flasks, but in the body of the infusions themselves.

By this method I tested in the first place the substance which, at an early stage of the inquiry, had excited my suspicion—without reference to which the discrepancy between the behaviour of infusions examined in the winter of 1875–76 and those examined in the winter of 1876–77 is inexplicable, but by reference to which the explanation of the observed discrepancy is complete—I mean the old hay which cumbered our laboratory floor.

Four hours' continual boiling failed to sterilize bulbs charged with infusions of this old hay. In special cases, moreover, germs were found so indurated and resistant that five, six, and in one case even eight hours' boiling failed to deprive them of life. All the difficulties encountered in this long and laborious inquiry were traced to the germs which exhibited the extraordinary powers of resistance here described. They introduced a plague into our atmosphere—the other infusions, like a smitten population, becoming the victims of a contagium foreign to themselves.[1]

It is a question of obvious interest to the scientific surgeon whether those powerfully resistant germs are amenable to the ordinary processes of disinfection. It is perfectly certain that they resist to an extraordinary extent the action of heat. They have been proved competent to cause infusions, both animal and vegetable, to purify. How would they behave in the wards of a hospital? There are, moreover, establishments devoted to the preserving of meats and vegetables. Do they ever experience inexplicable reverses? I think it certain that the mere shaking of a bunch of desiccated hay in the air of an establishment of this character might render the ordinary process of boiling for a few minutes utterly nugatory, thus possibly entailing serious loss. They have, as will subsequently appear, one great safeguard in the complete purgation of their sealed tins of air.

Keeping these germs and the phases through which they pass to reach the developed organism clearly in view, I have been able to sterilize the most obstinate infusions encountered in this inquiry by heating them for a minute fraction of the time referred to as *insufficient* to sterilize them. The fully developed bacterium is demonstrably killed by a temperature of 140° F. Fixing the mind's eye upon the germ during its passage from the hard and resistant to the plastic and sensitive state, it will appear in the highest degree probable that the plastic stage will be reached by different germs in different times. Some are more indurated than others and require a longer immersion to soften and germinate. For all known germs there exists a period of incubation during which they prepare themselves for emergence as the finished organisms which have been proved so sensitive of heat. If during this period, and well within it, the infusion be boiled for even the fraction of a minute, the softened germs which are then approaching their phase of final development will be destroyed. Repeating the process of heating every ten or twelve hours, and before the least *sensible* change has occurred in the infusions, each successive heating will destroy the germs then softened and ready for destruction, until after a sufficient number of heatings the last living germ will disappear.

Guided by the principle here laid down, and applying the heat discontinuously, infusions have been sterilized by an aggregate period of heating, which, 50 times multiplied, would fail to sterilize them if applied continuously. Four minutes in the one case can accomplish what 4 hours fail to accomplish in the other.

If properly followed out the method of sterilization here described is infallible. A temperature, moreover, far below the boiling point suffices for sterilization.

Another mode of sterilization equally certain, and perhaps still more remarkable, was forced upon me, so to speak, in the following way: In a multitude of cases a thick and folded layer of fatty scum, made up of matted *bacteria*, gathered upon the surfaces of the infusions, the liquid underneath becoming sometimes cloudy through it, but frequently maintaining a transparency equal to that of distilled water. The living scum-layer, as Pasteur has shown in other cases, appeared to possess the power of completely intercepting the atmospheric oxygen, appropriating the gas and depriving the germs in the liquid underneath of an element necessary to their development. Above the scum, moreover, the interior surfaces of the bulbs used in my experiments were commonly moistened by the water of condensation. Into it the *bacteria* sometimes rose, forming a kind of gauzy film to the height of an inch or more above the liquid. In fact, wherever air was to be found, the *bacteria* followed it. It seemed a necessity of their existence. Hence the question, What will occur when the infusions are deprived of air?

I was by no means entitled to rest satisfied with an inference as an answer to this question; for Pasteur, in his masterly researches, has abundantly demonstrated that the process of alcoholic fermentation depends on the continuence of life without air—other organisms than *torula* being also shown competent to live without oxygen. Experiments alone could determine the effect of exhaustion upon the particular organisms here under view. Air-pump vacua were first employed, and with a considerable measure of success. Life was demonstrably enfeebled in such vacua.

Sprengel pumps were afterwards used to remove more effectually both the air dissolved in the infusions and that diffused in the spaces above them. The periods of exhaustion varied from 1 to 8 hours, and the results of the experiments may be thus summed up: Could the air be completely removed from the infusions, there is every reason to believe that sterilization *without boiling* would in most, if not all cases, be the result. But, passing from probabilities to certainties, it is a proved fact that in numerous cases unboiled infusions deprived of air by 5 or 6 hours' action of the Sprengel pump are reduced to permanent barrenness. In a great number of cases, moreover, where the unboiled infusion would have become cloudy, exposure to the boiling temperature for a single minute sufficed completely to destroy the life already on the point of being extinguished through defect of air. With a single exception, I am not sure that any infusion escaped sterilization by 5 minutes' boiling after it had been deprived of air by the Sprengel pump. These 5 minutes accomplished what 5 hours often failed to accomplish in the presence of air.

The inertness of the germs in liquids deprived of air is not due to a mere *suspension* of their powers. They are *killed* by being deprived of oxygen. For when the air which has been removed by the Sprengel pump is, after some time, carefully restored to the infusion, unaccompanied by germs from without, there is no revival of life. By removing the air we stifle the life which the returning air is incompetent to restore.

[1] A hard and wiry hay from Guildford, which I have no reason to consider was found very difficult to sterilize.

OLD AGE.

THE problem of the life history of races is one which calls to its solution the profoundest study of the antiquarian, of the geologist, and even of the astronomer. Each species and variety of species does not seem, in the mass, to undergo evolution and development into higher forms of life; this lofty fate is reserved for the select few, while the species as such passes through maturity to decay and extinction.

Applied to man, these reflections have some very direct and practical bearings. There are a number of reasons to believe that organic life has in him reached its zenith and meridian altitude; that henceforward in the life history of this planet there will be gradual retrogression and a descent to inferior planes of being. It is even advanced, on grounds drawn from diverse sciences, that in the history of man the most brilliant intellectual epochs of his existence are, if not closed, at least almost so. Careful geodesic and astronomical studies fix the period of intellectual life on a planet of this size to a very limited period compared with its past history. Probably more than half of this period is already gone. Then there are signs of the early failure of many varieties of the race. The fate of the natives of this continent needs no profit to predict it. The Tasmanians have disappeared, to the last man. The Australians have greatly diminished. The New Zealanders and other Southern Pacific tribes are going with fearful rapidity.

It is claimed that races of greater vitality take their place. But what we call vitality may be deceptive. Modern art has probably added little to bodily vigor. Statistics tell the other way. All it does is to protect age and keep alive the invalids. This is what makes the mortality tables more cheering. There is much reason to believe that the general physical vigor of even the Aryan race is on the decline. One of the evidences for this discouraging conclusion, advanced by a well-known American zoölogist, is the relative length of the period of old age in the individual man. In youthful races the individual does not attain old age till very soon (relatively to the entire life) before death. The relative duration of old age grows longer and longer as the race grows older, until, in races which are about to pass away, it becomes nearly equal to half the entire interval between birth and death, soon after which the race dies out.

That men age more rapidly in modern life seems certain; nor is it altogether explained by the competition and extra brain work they encounter.

Can we successfully take up arms against this threatened decrepitude? The case is not hopeless. Perhaps by taking thought we can even get the better of "the abhorred advance of years." Some years ago an American physician wrote a daring article on "the chemical prevention of old age." Defining clearly to himself that all vital processes are none other than chemical ones, and those which are more particularly concerned in bringing about the physiological conditions of age are calcification and atheroma, he set to work to study whether a certain diet and regimen, assisted by certain remedies of well-known efficacy against these conditions, might not be devised, which would, if not prevent, at least long postpone these changes.

There is nothing absurd, nothing impossible, in the belief that a discovery of great value in this direction should be made. What is needed as a preliminary is a close appreciation of the histology of advanced life, an analysis of how it brings about failure of the powers, and experimental observations, in large numbers, on healthy elderly people.—*Medical and Surgical Reporter.*

LAWS GOVERNING THE PRODUCTION OF THE SEXES.

PROF. THURY published a pamphlet on "The Laws which Regulate Sex in Plants and Animals," which gives his scientific theory and practical directions. The following is a brief statement of his views. Starting with the vegetable kingdom, Prof. Thury adopts the theory of Knight, who, in concert with Wolff de Caredolle and Robert Brown, consider stamens and pistils to be fundamentally identical, (both being modifications of the leaf) and further regards the production of the male organ in plants as due to greater maturity or more perfect development.

Considering how general the laws of nature are the Professor infers that the propagation of animals follows an analagous course. He states that it has been already admitted that for certain oviparous animals, the last hatchings produce males; that Huber recognized it as a fact that early fecundation produces female bees, and *vice versa*; and so from one step to another he arrives at the conclusion that an egg (so called by physiologists) or germ, yet unimpregnated, is female during the first part of its passage down to the matrix, and male in the last part. The sex, then, of the creature will depend on the degree to which the egg is matured at the moment of fecundation. He therefore considers it to be a general law that fecundation which follows shortly after "heat," or menstruation, breeds female offsprings, and *vice versa*. Then follows practical directions and cautions.

He says: The peculiarities of different cows should be observed and taken into account. Exceptional animals, such as are fat or tied up, afford no criterion; but healthy, well-conditioned specimens, living in the open air, should be selected for experiment.

The number of hours that heat lasts varies from twenty-four to forty-eight. To obtain a heifer, the *first* part of this period is to be selected for breeding purposes; for a bull calf, the *latter* part.

BIRTH AND DEATH IN GREAT BRITAIN.—The birth and death rates of Great Britain in 1876 contrast as follows, according to the returns of the English registrar-general: England, birth rate per 1,000 of estimated population, 36.5; death rate, 21.21;—Scotland, birth rate, 35.9; death rate, 21;—Ireland, birth rate, 25.4; death rate, 17.4. It is possible that physiological reasons exist which make the death rate of the whole population somewhat dependent upon birth rate, apart from the increase of mortality arising from a large new-born population. But whether the more numerous progeny has less vitality or greater vitality, in comparison with less numerous offspring, is a question upon which our statistical progress shows either no light or that which is but uncertain.

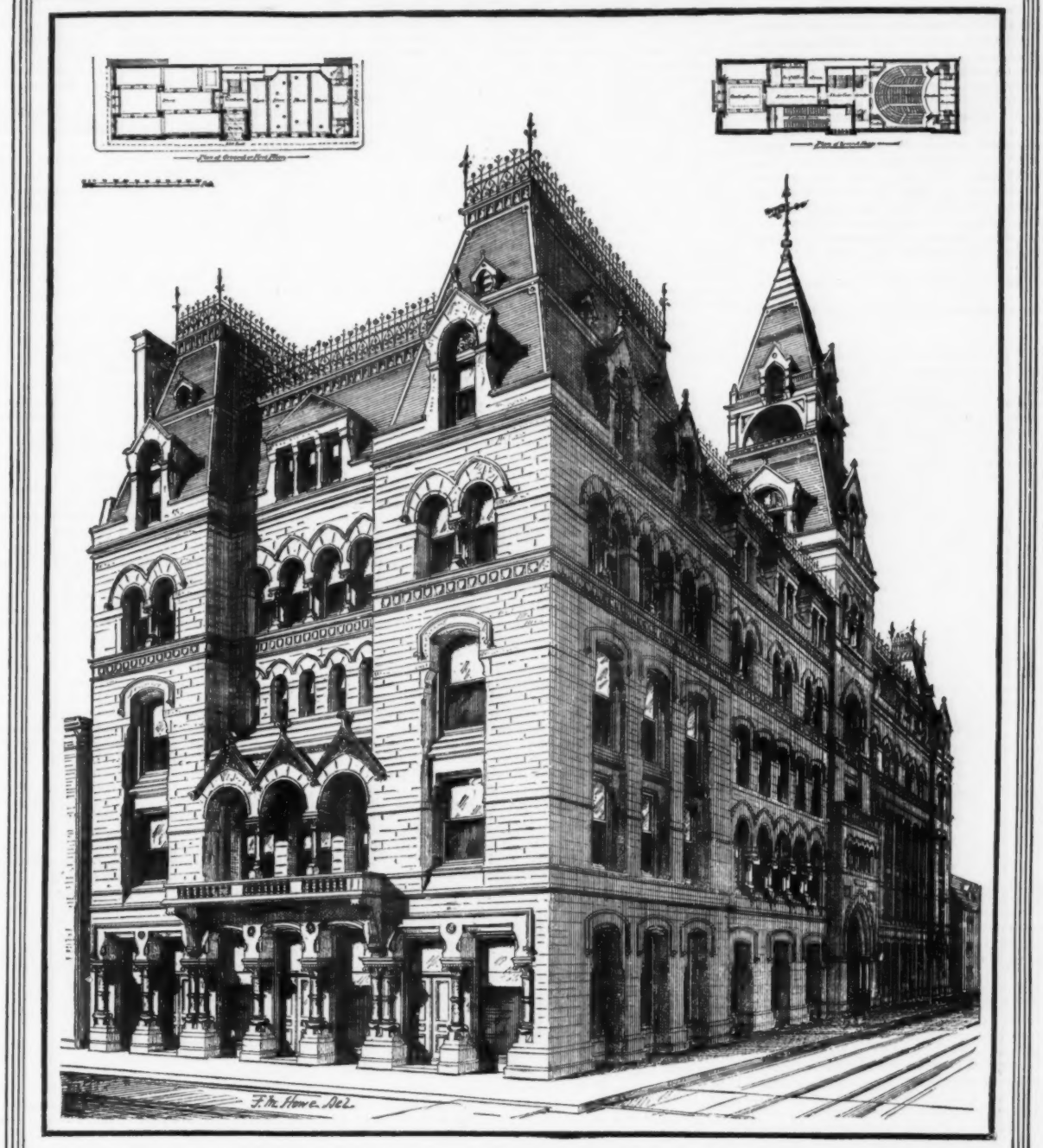
BICHROMATE OF POTASH AS AN ANTISEPTIC.

M. LAUJORROIS lately presented a note to the French Academy, on the antiseptic properties of bichromate of potash. Experiments had shown him that addition of one-hundredth part of bichromate in ordinary water prevents the putrefaction of all sorts of organic matter, such as meat, urine, etc. A thousandth part of bichromate prevents beer from turning sour. After three months' immersion in a solution, meat was hardened and dry.

THE VEGETABLE ORIGIN OF MALARIA.

DR. SALISBURY, of Ohio, some years ago claimed to have discovered the microscopic vegetation which produces malarial disease. Recently, two Italian physicians, Signori Lanzi and Terrigi (*Monthly Microscopical Journal*), have discovered minute dark granules belonging to Cohn's group of pigmented sphæro-bacteria within the endochrome of algæ, which increase in number with decay of the latter. These granules yield on cultivation the *Monilia penicillata* of Fries, and are identical with the pigment granules of the liver, spleen, and blood of those who have suffered from malarial diseases. Lanzi has even obtained a *Zooglæa* by cultivation of these granules from a human liver. On the evaporation of the marshy pools of the Campagna in summer, great sheets of decomposing algæ are exposed to the air, the sphæro-bacteria abound, and are found floating in vast numbers in the atmosphere, to the height of fifty centimetres above the level of the marsh.

BUILDING OF THE Y. M. C. ASSOCIATION.
PHILADELPHIA.



ADDISON HUTTON, ARCHITECT.

THE YOUNG MEN'S CHRISTIAN ASSOCIATION BUILDING, PHILADELPHIA, PENN., MR. ADDISON HUTTON, ARCHITECT.

THE new building for the Young Men's Christian Association has a front of 72 feet on Chestnut Street, the same on Sansom Street, and of 230 on Fifteenth Street; it is five stories in height including the mansard roof, and has a basement story, together with vaults under the sidewalks ten feet clear depth. The first story is divided midway on Fifteenth Street by the entrance (25 feet wide) and staircase to the upper stories. The northern portion to Chestnut Street front is divided into three stores of 24' x 100', and the southern part into four stores fronting on Fifteenth Street. The second story contains, on the north, the secretary's rooms, a large reception-room, a prayer-room, and a reading-room and library, extending through two stories; on the fourth, the Association Hall, with two curved galleries, and two stairways to Sansom Street. The seating capacity is 1,300; the seats are upholstered chairs. There are a few rooms on the third, fourth, and fifth floors to be let as offices. A feature worthy of remark on the fourth floor is the gymnasium, which occupies the breadth of the front by 40 feet in depth, and extends in height into the fifth story. Being placed over the reading-room, great pains have been taken (and with marked success) to deafen the floor. This is done by covering the counter flooring with about two inches of calcined plaster mixed with sawdust. The Association Hall has proved a perfect success with regard to sound, and is much sought after for musical purposes. All the walls are brick, but the three fronts from base to cornice, and including the latter, are faced with Ohio (Amherst) stone, square drove. The base is Quincy granite, and the shafts throughout of polished Scotch granite. The interior is finished mostly with shellacked cypress wood, except the stairs; some of these are ash; the main stairway is oak. The sashes and shutters are generally of walnut; the store doors and window frames are of mahogany. The ceiling-light and windows of the Association Hall and of the prayer-room and main stairs are rich with stained glass. All other principal windows are filled with polished French plate-glass. Steam is used for warming the building by direct radiation; and the ventilation is aided by steam-coils, placed in four large ventilating stacks. The boilers, placed under the sidewalk, afford the power for running a passenger-elevator, which plies from the first to the fifth floor, and also for pumping the water to a 5,000-gallon reservoir in the tower, which supplies the greater part of the building. Electricity is called into play in lighting up the Association Hall, and is found to serve the purpose in a most satisfactory manner.

We are indebted to the *American Architect and Building News* for the foregoing particulars and the illustration given herewith.

THE SIZE OF LONDON.

LONDON, the greatest city the world ever saw, covers, within a fifteen-mile radius of Charing Cross, nearly 700 square miles. It numbers more than 4,000,000 inhabitants. It comprises 100,000 foreigners from every quarter of the globe. It contains more Roman Catholics than Rome itself; more Jews than the whole of Palestine; more Irish than Dublin; more Scotchmen than Edinburgh; more Welshmen than Cardiff. It has a birth in it every five minutes, and a death in it every eight minutes; has seven accidents every day in its 7,000 miles of streets; has 123 persons every day, and 45,000 annually, added to its population; has 117,000 habitual criminals on its police register; has 23,000 prostitutes; has as many public houses as would, if placed side by side, stretch from Charing Cross to Portsmouth; has 38,000 drunkards annually brought before its magistrates; has as many paupers as would more than fill every house in Brighton; has 60 miles of open shops every Sunday; and has an influence on the world represented by the yearly delivery in its postal districts of 238,000,000 letters.—*Med. Press and Circular.*

PETROLEUM.

STOWELL'S *Reporter* gives the following statistics of this industry, at the end of July of this year.

Stock on hand at the wells	109,224	Bbls.
Production for the month	1,189,005	"
Daily production	38,355	"
Number of producing wells	7,567	
Number of drilling wells	365	
Stock in iron tanks, pipe line and refineries	2,895,504	"
Total stock on hand, Aug. 1, 1877	3,004,728	"
Total shipments for the month	1,096,951	"

DETECTION OF CRIMINALS BY THE MICROSCOPE.

IN a recent lecture, Mr. Thomas Taylor, microscopist to the Department of Agriculture, Washington, D. C., exhibited on a screen a view of the markings on the palms of the hands and tips of the fingers, and called attention to the possibility of identifying criminals, especially murderers, by comparing the marks of the hands left upon any object with impressions in wax taken from the hands of suspected persons. In the case of murderers, the marks of bloody hands would present a very favorable opportunity. This is a new system of palmistry.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE annual meeting took place at Nashville, Tenn., on the 29th of August, in the Hall of Representatives of the State Capitol. Prof. Hall introduced the President-elect, Prof. Newcomb, of Washington, and a letter was read by the Secretary from President Rogers, regretting his enforced absence and gracefully alluding to the new bond between northern and southern scientists cemented by the present meeting. The President made a suitable acknowledgment. Mayor of Nashville in a lively speech welcomed the Association very cordially to the city, and he was followed in the same strain by the chairman of the local committee, who made some excellent remarks on public school education as the basis of scientific training. To all these President Newcomb made a happy reply, saying that there were no politics in science, and no record of her killing human beings for matters of opinion.

In lieu of the presidential address informal lectures were given by President Newcomb on the two great discoveries of this year: that of oxygen in the sun by Dr. Henry Draper, and that of the satellites of Mars by Prof. Hall, of Washington. Prof. James Hall, of New York, gave an interesting address on the progress of American Geology, followed by Prof. J. Lawrence Smith, on Meteorites. A paper on an International Scientific Service was read by Prof. Grote, of Buffalo.

We are indebted to the New York *Tribune* for the following reports:

The following is the chief part of the address of Professor Grote on

"AN INTERNATIONAL SCIENTIFIC SERVICE."

The time seems near at hand when, by an International Scientific Organization, the efforts of the best scientific minds of the more civilized nations may be joined for the solution of those problems which all are alike forced to grapple with, and which of themselves constitute the sufficient proof of a larger kinship than is expressed by the political boundaries of the globe. The benefit which humanity has derived from the formation of local societies for the advancement of knowledge need not be rehearsed at this time. It is sufficient to say that they have proved admirable guides to the intelligence which produced them. The existing national associations in this country and in Europe are performing excellent work; but there are other questions, to the answering of which their means are inadequate. Foremost among them there is that of the origin of our species. Indispensable to a correct basis of thought is the solution of this question, and the elucidation must be sought for in regions outside of those inhabited by the more civilized nations. (I would refer to a paper "On the Peopling of America," read before the Buffalo Society of Natural Sciences in February, and reprinted in *The American Naturalist* for April, 1877.) The various scientific explorations in Africa, Australia and the polar regions need coöperative assistance to realize the best results from the outlays, while the new knowledge they bring is the common inheritance of all reading peoples. Justice, then, would require that where all participate all should contribute. The plan of the International Scientific Service here provisionally proposed embraces the appointments of Commissioners by the civil governments of the world, whose deliberations would be the wisdom of the age, and whose recommendations would be respected by the legislative powers of the consenting and represented nations. Under their auspices all extralimital astronomical, geographical and biological expeditions would be fitted out and directed to those places which would be more fruitful for the particular purpose. No longer would we be subjected to failures arising directly or indirectly from national prejudices. The difference in the mental faculties between different nations would prevent the loss in such a body of any possible suggestion the human intellect could afford.

From an economical point of view, the outlay of the different governments for scientific expeditions would be lessened, and more effective work would be done.

The amount to be contributed would be less, because the expense of any expedition to be decided upon by the service would be made up by a quota from all the governments represented. The tendency to enlarge our application of good conduct is destructive to a narrow national sentiment; this is a sentiment which is only laudable when it tends to preserve a high morality, and it is weaker where the intellect is more advanced. When science takes hold of the brotherhood of nations and calls upon them to undertake the solution of vital problems for the common good, there must surely be a glorious response. Of the existing sympathy between the nations we have many ready proofs. The Austrian polar expedition is rescued by "foreigners," and America returns to England the ship lost in northern ice. The flag of the International Scientific Service should be made neutral by treaty, and would be held sacred by all.

As tending to break down social prejudice, as working in a direction toward greater economy and greater result, I venture to lay the proposition before this Association that it memorialize Congress to appoint commissioners on the part of the United States, who would inaugurate the formation of such an International Scientific Organization, and, by resolutions to be passed by this Association, invite a similar action on the part of kindred scientific bodies in other lands as would influence their respective governments to assist in the enterprise.

It seems to me that some such steps as I now speak of will eventually be taken. If the plan proposed be now acted upon, it will be at least a fitting thing that it was commenced by a country that protects the alien, and allows liberty to all its inhabitants to pursue their happiness. And it would be well for America to move in any matter that will create an active sympathy between the nations in scientific matters. For so will free institutions be the more readily preserved. Knowledge, of itself, brings a conduct that must give at last tolerance and good-will to all mankind. Obviously, then, any plan that will decrease and diffuse our stock of experience should be adopted.

The course to be pursued by well balanced minds in handling questions as to the tendency of human conduct seems to be plainly the cultivation of knowledge, so that we may get more light as to our proper behavior.

THE SATELLITES OF MARS.

The following portion of Prof. Newcomb's remarks concerning Prof. Hall's discoveries contains several estimates and particulars that have not yet been previously presented.

The inner satellite of Mars goes around the planet in less than eight hours, while Mars himself revolves in twenty-four hours. The consequence of this is that this satellite rises in the west and sets in the east; that is, the motion of the satellite around the planet towards the east is more rapid than the planet itself, and thus is an exception to any other of the heavenly bodies. If there are any astronomers on the planet Mars, that have had to go through the same discoveries with the planets as we have had on the earth, then indeed the satellite must have been the source of very great complication and difficulty. The outer one, notwithstanding its proximity, is so small that from the surface of Mars it would look rather more like the planet Venus than like the moon. To determine the diameter of these satellites is extremely difficult, looking at them with a telescope, and the only way is by judging of the amount of light which they give. It is found by this that the outer satellite gives about one hundred thousandth part as much light as Mars, or perhaps the proportion may be two or three or several thousandths less; therefore the diameter of Mars must be three or four hundred times the diameter of the satellite. The diameter of Mars is only four thousand miles; divide that by four hundred gives ten miles for the diameter of the satellite; which is probably a good estimate. It may be as small as four or five miles; it can hardly be more than thirty.

The inner one is rather brighter than the other, and is plainly visible. The diameter may not be less than ten miles, or as much as forty or fifty. Its nearest body to the earth is the moon—240,000 miles. The inner of these two satellites is only 6,000 miles from the center of the planet, and from the circumference of Mars not very much further than the breadth of the Atlantic. The moon, the nearest of the heavenly bodies, is sixty times as far from us as this satellite is from the inhabitants of Mars.

The second day's proceedings were rendered particularly interesting by the delivery of an address on "Ancient Life in America," by Prof. Marsh, of New Haven, Conn.

ANCIENT LIFE IN AMERICA.

BY PROF. O. C. MARSH.

The origin of life, and the order of succession in which its various forms have appeared upon the earth, offer to science its most inviting and most difficult field of research. Although the primal origin of life is unknown, and may perhaps never be known, yet no one has a right to say how much of the mystery now surrounding it science cannot remove. It is certainly within the domain of science to determine when the earth was first fitted to receive life, and in what form the earliest life began. To trace that life in its manifold changes through past ages to the present is a more difficult task, but one from which modern science does not shrink. In this wide field, every earnest effort will meet some degree of success; every year will add new and important facts, and every generation will bring to light some law, in accordance with which ancient life has been changed into life as we see it around us to-day. That such a development has taken place, no one will doubt who has carefully traced any single group of animals through its past history, as recorded in the crust of the earth. The evidence will be especially conclusive if the group selected belongs to the higher forms of life, which are sensitive to every change in their surroundings. But I am sure I need offer here no argument for evolution; since to doubt evolution to-day is to doubt science, and science is only another name for truth.

EARLIEST FISHES OF THIS CONTINENT.

According to present knowledge, no vertebrate life is known to have existed on this continent in the archæan, Cambrian, or silurian periods; yet during this time more than half of the thickness of American stratified rocks was deposited. It by no means follows that vertebrate animals of some kind did not exist here in those remote ages. Fishes are known from the upper silurian of Europe, and there is every probability that they will yet be discovered in our strata of the same age, if not at a still lower horizon.

In the shore deposits of the early Devonian sea, known as the Schoharie grit, characteristic remains of fishes were preserved, and in the deeper sea that followed, in which the corniferous limestone was laid down, this class was well represented. During the remainder of the Devonian, fishes continue abundant in the shallower seas, and, so far as now known, were the only type of vertebrate life.

With the close of the Devonian, came the almost total extinction of the great group of placoderms, while the elasmobranchs, which had hitherto occupied a subordinate position, increase in numbers and size, and appear to be represented by sharks, rays, and chimeras. The elasmobranchs were the rulers of the carboniferous open sea, and more than one hundred species have been found in the lower part of this formation alone. The ganoids, although still abundant, were of smaller size and denizens of the more shallow and confined waters.

From the Permian rocks of America no vertebrate remains are known, although in the same formation of Europe ganoids are abundant; and with them are remains of sharks, and some other fishes, the affinities of which are doubtful. The palæozoic fishes at present known from this country are quite as numerous as those found in Europe.

In the mesozoic age, the fishes of America begin to show a decided approach to those of our present waters. From the triassic rocks, ganoids only are known, and they are all more or less closely related to the modern gar-pike, or *lepidosteus*. From the jurassic deposits, no remains of fishes are known, but in the cretaceous, ichthyic life assumed many and various forms; and the first representatives of the teleosts, or bony fishes, the characteristic fishes of to-day, make their appearance.

The tertiary fishes are nearly all of modern types, and from the beginning of this period there was comparatively little change. In the marine beds, sharks, rays and chimæroids maintained their supremacy, although teleosts were abundant, and many of them of large size. The ganoids were comparatively few in number. In the earliest eocene fresh-water deposits, it is interesting to find that the modern gar-pike, and *amia*, the dog-fish of our western lakes, which by their structure are seen to be remnants of a very early type, are well represented by species so closely allied to them that only an anatomist could separate the ancient from the modern.

The almost total absence of remains of the fishes from the miocene lake basins of the West is a remarkable fact, and perhaps may best be explained by the theory that these inland waters, like many of the smaller lakes in the same region to-day, were so impregnated with mineral matters as to render the existence of vertebrate life in them impossible. No one who has tasted such waters, or has attempted to ford one of the modern alkaline lakes which are so often met with on the present surface of the same deposits, will doubt the efficiency of this cause, or the easy entombment of the higher vertebrates that ventured within their borders. In the pliocene lake basins of the same region, remains of fishes were not uncommon, and in some of them are very numerous. These are all of modern types, and most of them are cyprinoids related to the modern carp. The post-pliocene fishes are essentially those of to-day.

THE AMPHIBIANS.

The amphibians, the next higher class of vertebrates, are so closely related to the fishes in structure, that some peculiar forms of the latter have been considered by anatomists as belonging to this group. The earliest evidence of amphibian existence, on this continent, is in the sub-carboniferous, where foot-prints have been found which were probably made by labyrinthodonts, the most ancient representatives of the class.

No amphibia are known from American permian strata, but in the triassic, a few characteristic remains have been found.

The amphibia are so nearly allied to the ganoid fishes that we can hardly doubt their descent from some member of that group. With our present limited knowledge of the extinct forms, however, it would be unprofitable to attempt to trace in detail their probable genealogy.

The authors to whom especial credit is due for our knowledge of American fossil fishes and amphibians are Newberry, Leidy, Cope, Dawson, Agassiz, St. John, Gibbes, Wyman, Redfield, and Emmons, and the principal literature of the subject will be found in their publications.

ABUNDANCE OF REPTILES.

Reptiles and birds form the next great division of vertebrates, the sauropsida, and of these the reptiles are the older type, and may be first considered. While it may be stated with certainty that there is at present no evidence of the existence of this group of American rocks older than the carboniferous, there is some doubt in regard to their appearance even in this period.

The mesozoic period has been called the age of reptiles, and during its continuance some of the strangest forms of reptilian life made their appearance, and became extinct. Near its commencement, while the triassic shales and sandstones were being deposited, true reptiles were abundant. In the same strata in which the lelodonts occur, remains of dinosaurs are found, and it is a most interesting fact that these highest of reptiles should make their appearance, even in a generalized form, at this stage of the earth's history. The dinosaurs, although true reptiles in all their more important characters, show certain well marked points of resemblance to existing birds of the order *ratitæ*, a group which includes the ostriches; and it is not improbable that they were the parent stock from which birds originated.

During triassic time, the dinosaurs attained in America an enormous development both in variety of forms and in size. Although comparatively few of their bones have as yet been discovered in the rocks of this country, they have left unmistakable evidence of their presence in the foot-prints and other impressions upon the shores of the waters which they frequented. The triassic sandstone of the Connecticut Valley has long been famous for its fossil foot prints, especially the so-called "bird-tracks," which are generally supposed to have been made by birds, the tracks of which many of them closely resemble. A careful investigation, however, of nearly all the specimens yet discovered, has convinced me that there is not a particle of evidence that any of these fossil impressions were made by birds. Most of these three-toed tracts were certainly not made by birds, but by quadrupeds which usually walked upon their hind feet alone, and only occasionally put to the ground their smaller anterior extremities. I have myself detected the impressions of these naterior limbs in connection with the posterior foot-prints of nearly all of the supposed "bird-tracks" described, and have little doubt that they will eventually be found with all. These double impressions are precisely the kind which dinosaurian reptiles would make, and as the only characteristic bones yet found in the same rocks belong to animals of this group, it is but fair to attribute all these foot-prints to dinosaurs, even where no impressions of fore-feet have been detected, until some evidence appears that they were made by birds. I have no doubt that birds existed at this time, although at present the proof is wanting.

It will be seen that, although reptilian life was especially abundant during the triassic and jurassic periods, but few bones have been found. This is owing in character of most of the rocks then formed, which were not well fitted for preserving such remains, although admirably adapted to retain foot-prints.

During the cretaceous period, reptilian life in America attained its greatest development, and the sediments laid down in the open seas and estuaries were usually most favorable for the preservation of a faithful record of its various phases.

ANCIENT SAURIAN MONSTERS.

The reptiles most characteristic of our American cretaceous strata are the *mosasauria*, a group with very few representatives in other parts of the world. In our cretaceous seas, they ruled supreme, as their numbers, size, and carnivorous habits enabled them to easily vanquish all rivals. Some were at least sixty feet in length, and the smallest ten or twelve. In the inland cretaceous sea from which the Rocky Mountains were beginning to emerge, these ancient "Sea Serpents" abounded; and many were entombed in its muddy bottom. On one occasion, as I rode through a valley washed out of this old ocean bed, I saw no less than seven different skeletons of these monsters in sight at once. The mosasaurs were essentially swimming lizards, with four well developed paddles, and they had little affinity with modern serpents, to which they have been compared.

The *crocodilia* are abundant in rocks of cretaceous age in America, and two distinct types are represented. The tertiary marine beds of the Atlantic Coast contain comparatively few crocodilian remains, and all are of modern types; the genus *gavialis* having one eocene species, and the alligator being represented only in the latest deposits.

It is worthy of special mention in this connection, that no true *lacertilia*, or lizards, and no *ophidia*, or serpents, have yet been detected in American cretaceous beds; although their remains, if present, would hardly have escaped observation in the regions explored. The former will doubtless be found, as several species occur in the mesozoic of Europe; and perhaps the latter, although the ophidians are apparently a more modern type. In the eocene lake-basins of Western America, remains of lizards are very numerous, and indicate species much larger than any existing to-day.

The first American serpents, so far as now known, appear in the eocene, which contains also the oldest European species.

The *pterosauria*, or flying lizards, are among the most in-

teresting reptiles of mesozoic time, and many of them left their remains in the soft sediments of our inland cretaceous sea. These were veritable dragons, having a spread of wings of from ten to twenty-five feet.

The strange reptiles known as *dinosauria*, which, as we have seen, were numerous during the deposition of our triassic shales and sandstones, have not yet been found in American jurassic, but were well represented here throughout the cretaceous, and at its close became extinct. These animals possess a peculiar interest to the anatomist, since, although reptilian in all their main characters, they show clear affinities with the birds, and have some features which may point to mammals. The cretaceous dinosaurs were all of large size, and most of them walked on the hind feet alone, like modern struthious birds. Near the base of our cretaceous formation, in beds which I regard as the equivalent of the European wealden, the most gigantic forms of this order yet discovered have recently been brought to light. One of these monsters (*titanosaurus montanus*), from Colorado, is by far the largest land animal yet discovered; its dimensions being greater than was supposed possible, in an animal that lived and moved upon the land. It was some fifty or sixty feet in length, and, when erect, at least thirty feet in height. It doubtless fed upon the foliage of the mountain forests, portions of which are preserved with its remains. With *titanosaurus*, the bones of smaller dinosaurs—one (*nanosaurus*) not larger than a cat—as well as those of crocodiles and turtles, are not uncommon. The recent discovery of these interesting remains, many and various, in strata that had long been pronounced by professional explorers barren of vertebrate fossils, should teach caution to those who decline to accept the imperfection of our knowledge to-day as a fair plea for the supposed absence of intermediate forms.

In the marine cretaceous beds of the West, only a single dinosaur (*hadrosaurus agilis*) has been found, but in the higher fresh-water beds, which mark the close of this formation, their remains are numerous, and indicate several well marked species, if not genera.

THE BIRDS WITH TEETH.

The first appearance of birds in America, according to our present knowledge, was during the cretaceous period, although many announcements have been made of their existence in preceding epochs. The evidence of their presence in the trias, based on footprints and other impressions, is, at present, as we have seen, without value; although we may confidently await their discovery there, if not in older formations. *Archæopteryx*, from the European Jura, the oldest bird known, and now fortunately represented by more than a single specimen, clearly indicates a much higher antiquity for the class. The earliest American forms, at present known, are the *odontornithes*, or birds with teeth, which have been exhumed within the last few years from the chalk of Kansas. The two genera, *hesperornis* and *ichthyornis*, are types of distinct orders, and differ from each other and from *archæopteryx* much more than do any existing birds among themselves; thus showing that birds are now a closed type, and that the key to the history of the class must be sought for in the distant past.

In *hesperornis*, we have a large aquatic bird, nearly six feet in length, with a strange combination of characters. The jaws are provided with teeth, set in grooves; the wings were rudimentary, and useless; while the legs were very similar to those of modern diving birds. This last feature was merely an adaptation, as the more important characters are struthious, showing that *hesperornis* was essentially a carnivorous swimming ostrich. *Ichthyornis*, a small flying bird, was stranger still, as the teeth were in sockets; and the vertebræ biconcave, as in fishes and a few reptiles. *Apatornis* and all other allied forms occur in the same beds, and probably all were provided with teeth. It is strange that the companions of these ancient toothed birds should have been edentate without teeth. In the later cretaceous beds of the Atlantic coast, various remains of aquatic birds have been found, but all are apparently distinct from those of the West.

During the tertiary period birds were numerous in this country, and all yet discovered appear to have belonged to modern types.

It is now generally admitted by biologists who have made a study of the vertebrates, that birds have come down to us through the dinosaurs, and the close affinity of the latter with recent struthious birds will hardly be questioned. The case amounts almost to a demonstration, if we compare, with dinosaurs, their contemporaries, the mesozoic birds. The classes of birds and reptiles as now living are separated by a gulf so profound that a few years since it was cited by the opponents of evolution as the most important break in the animal series, and one which that doctrine could not bridge over. Since then, as Huxley has clearly shown, this gap has been virtually filled by the discovery of bird-like reptiles and reptilian birds. *Compsognathus* and *archæopteryx* of the Old World, and *ichthyornis* and *hesperornis* of the New, are the stepping stones by which the evolutionist of to-day leads the doubting brother across the shallow remnant of the gulf, once thought impassible.

DIVISION BETWEEN CRETACEOUS AND TERTIARY.

It remains now to consider the highest group of the animal kingdom, the class *mammalia*, which includes man. Of the existence of this class before the trias we have no evidence, either in this country or the Old World, and it is a significant fact that, at essentially the same horizon in each hemisphere, similar low forms of mammals make their appearance. Although only a few incomplete specimens have been discovered, they are characteristic and well preserved, and all are apparently marsupials, the lowest mammalian group which we know in this country, living or fossil. The American triassic mammals are known only from two small lower jaws, on which is based the genus *dromotherium*, supposed to be related to the insect-eating *myrmecobius*, now living in Australia.

Although the Jura of Europe has yielded other similar mammals, we have as yet none of this class from that formation; while, from rocks of cretaceous age, no mammals are known in any part of the world.

In the lowest tertiary beds of this country a rich mammalian fauna suddenly makes its appearance, and from that time through the age of mammals to the present, America has been constantly occupied by this type of life in the greatest diversity of form. Fortunately, a nearly continuous record of this life, as preserved, is now accessible to us, and ensures great additions to our knowledge of the genealogy of mammals, and perhaps the solution of more profound problems.

The boundary line between the cretaceous and tertiary in the region of the Rocky Mountains has been much in dispute during the last few years, mainly in consequence of the uncertain geological bearings of the fossil plants found near this horizon. The accompanying invertebrate fossils have thrown little light on the question, which is essential, whether the great lignite series of the West is uppermost cretaceous or lowest eocene. The evidence of the numerous vertebrate remains is, in my judgment, decisive, and in favor of the former view.

This brings up an important point in palæontology, one to which my attention was drawn several years since, namely: the comparative value of different groups of fossils in marking geological time. In examining the subject with some care, I found that for this purpose plants, as their nature indicates, are most unsatisfactory witnesses; that invertebrate animals are much better; and that vertebrates afford the most reliable evidence of climate and other geological changes. The sub-divisions of the latter group, moreover, and, in fact, all forms of animal life, are of value in this respect, mainly according to the perfection of their organization or zoölogical rank. Fishes, for example, are but slightly affected by changes that would destroy reptiles or birds, and the higher mammals succumb under influences that the lower forms pass through in safety. The more special applications of this general law, and its value in geology, will readily suggest themselves.

The evidence offered by fossil remains is, in the light of this law, conclusive, that the line, if line there be, separating our cretaceans from the tertiary, must at present be drawn where the dinosaurs and other mesozoic vertebrates disappear, and are replaced by the mammals, henceforth the dominant type.

(To be continued.)

THE RICE CROP OF THE UNITED STATES.

THE first rice was sown in this country by Sir William Berkeley, in Virginia, in the year 1647. The finest variety is raised from seed accidentally procured from a vessel that put into Charleston in 1694, on her voyage from Madagascar. Prior to the civil war (1860) the culture was in the main confined to the Atlantic coast States (North and South Carolina and Georgia). The yield at that time annually averaged 170,000 casks of 650 pounds net. As most of the plantations were situated at or near the scene of active military operations, their destruction naturally followed, and rice growing almost entirely suspended. In 1865 the planting was resumed, the product of the first year being 4,000 casks. This has since enlarged to an average of 80,000 casks per annum. Rice was also grown to a limited extent, about 7,500 barrels, in the State of Louisiana, prior to 1860. As it was of low grade and reddish hue, it did not enter general trade, but was consumed by the inhabitants of that locality. Necessity, during the war, compelled more attention to be paid to its culture; this, and a series of misfortunes which overtook many of the sugar planters, has caused an increase of production until the growth last year amounted, says the *American Mail*, to 175,000 barrels of 225 pounds net weight. The manner of cultivation in this country is not uninteresting. A small percentage of the crop is raised on the uplands, but the lands most commonly used and best adapted for the growth of the higher kinds and qualities are the alluvial swamps on the banks of rivers, so situated as to be flooded with fresh water, at high tide, by the opening of a floodgate. The plantations are embanked, as also are their subdivisions, which are squares, varying from 15 to 20 acres in size, each of the latter having its separate and smaller floodgate, by which the water may be supplied or withdrawn as the growth of the individual plot may demand. The seed is planted during April and May, in open or covered trenches made 15 inches apart. The water is then drawn on sufficiently to cover the ground; this is technically termed the "sprout flow." After the seed has sprouted the water is withdrawn and the field allowed to dry. When the blade is about two inches long (the "needle state") it is again flooded, this being termed the "stretch flow," which is generally left on a couple of weeks, or until the rice is about a foot high, when the water is again drawn off. The crop at this point is hoed and freed from weeds and foreign seed. This dry growth continues until it "joints" or the heads begins to form; then is put on "harvest flow," which is kept on at full height until the crop is ready to cut. The grain is harvested by hand with sickles.

A PRIZE ENGLISH FARM.

FOR several years past the Royal Agricultural Society of England has offered substantial prizes for the best managed farms in the countries which form the district in which the show is held. This season the competitors were divided into eight classes, viz.: 1st, arable farms above 150 acres in extent; 2, arable farms above 80 and under 150 acres; 3d, farms above 40 and under 80 acres; 4th, dairy or meat-producing farms above 200 acres; 5th, ditto, not less than 100 but under 200 acres; 6th, farms of not less than 50 but under 100 acres; classes 7 and 8, for farms in the Isle of Man.

It happens again this year, as has been the case on one or two previous occasions, that a woman's management wins—the prize in class first going to Mrs. Ellen Birch, for a farm of 242 acres, all arable land, at Aintree, near Liverpool. The farm, like the surrounding region, is nearly level; is divided into fields of about 30 acres each, by neatly kept hedges, and is light and easily worked soil, naturally dry. No stock of consequence is kept, as town manure is cheaply brought on to the land by canal from Liverpool, for which market the products of the land are intended. The rent paid is £5, say about $25, per acre. The course of cropping is as follows: 1st, potatoes, after lea; 2d, wheat; 3d, barley or oats, sown with grass seeds; 4th, hay; 5th, hay; after which the lea is again broken out and planted with potatoes. The potato crop now on the ground is spoken of as "simply splendid." And it is on the potatoes that all the town and home made manure is applied, sometimes with the addition of a little nitrate of soda. The grain crops, especially the oats, were very heavy. Fifteen men and lads are employed, at 16 and 17 shillings a week, and cottage rent. Heavy crops of hay are grown, and after this is over for the season, sheep are taken in to grass from local salesmen, at sixpence per week. The farm has been in the continuous occupation of the same family for 35 years, being conducted now by the widow of the tenant, assisted by her two sons.

LARGE WHITE OAK IN MICHIGAN.—Mr. Dow Lyon, of St. Johns, Mich., says he has a white oak growing which at three feet from the ground measures seventeen and a half feet in circumference, and he judges that the first large limb is sixty five feet from the ground. It is very symmetrical for the first forty feet or so.

HOW PLUMS ARE MADE INTO PRUNES.

OREGON and California being fortunately as yet free from that destructive pest to all stone fruits, the curculio, the plum flourishes there, and produces most generous crops. We have had several inquiries from these States, asking how plums are converted into prunes. As this is outside of the line of our experience, the best we can do is to give the methods described by French authors, and followed in the country from whence we derive nearly all of this kind of fruit. It is generally supposed that any plums may be dried into prunes; this is a mistake; in France the varieties fit for the purpose form a distinct group, and in districts celebrated for the quality of their prunes, such as Tours, Angers, Provence, etc., they cultivate some special variety. The leading varieties are the Brignolles, D'Angen, Quetsche, and Perdrigon Violet, which are but little known in this country; the St. Catharine and Pond's Seedling, well-known European varieties, and the Washington, of course American, are sometimes cultivated, but to a limited extent, in some localities. The plums are allowed to get so ripe that they fall from the trees, and to prevent injury by the fall, the ground beneath the trees is either made soft by working with the plow or harrow, or is covered with straw. The fruit, which is picked up every day, or every other day, is washed if soiled, and then spread upon wicker trays made for the purpose; these are either circular, or egg-shaped, or rather the shape of a battledoor, the narrow end coming to a point to serve as a handle; they are about 20 inches across. The drying is done by exposure to both the sun and to fire heat, ordinary baker's ovens being used, or ovens are especially built for the purpose. The object is to dry the fruit as rapidly as possible, without breaking the skin. The fruit, in a single layer in the trays, is exposed for several days to the sun, where it is carefully turned from time to time, in order that all parts may be equally exposed. Neither of several French writers mention just how long this continues, but as all agree in saying it is for the purpose of toughening the skin, we infer that it differs with circumstances, and that the proper condition is only learned by practice. The trays of fruit are placed in an oven heated from 165° to 175° Fah., and the mouth of the oven securely closed. At the end of 24 hours the fruit is taken out, and when completely cold, it is turned upon the tray. In the meantime the oven is reheated, this time from 212° to 230°, and the fruit placed in again, where it remains as before; after another cooling and turning, the oven being heated to 255°, the third drying is given, and this generally completes the process, though it is sometimes necessary to return the fruit to the oven once more. The prunes are known to be properly done if they have a certain degree of elasticity when pressed by the fingers. They should have perfect skins, which shine as if varnished, and be free from all scorching. In France it is customary for the growers and dryers of the fruit to sell it to the packers in Bordeaux and other markets, where three grades are recognized, founded on the number of prunes required to weigh 500 grammes, or a trifle over a pound and a quarter. If 70, or less, weigh this, they are "fine;" if it requires 80, they are "medium," and "small" if 90 or more are required. In packing, the fruit is assorted in the same manner, the "superfine" being selected prunes, 30 to 35 of which weigh 500 grammes, and down through several grades. In particular localities the process of drying is varied; in Provence the fruit is scalded before drying. In some of the finer kinds the prune, before entering the oven for the last time, is rounded, by turning the stone within, and flattening the ends, without breaking the skin. The Brignolles prunes have the fruit peeled, strung upon sticks, and dried in the sun; when nearly dry the stone is removed, and the drying finished. For the common prunes, such as are imported in casks, the fruit is shaken from the trees, and does not receive such special care in drying. It is important that those on the Pacific coast and elsewhere, who wish to undertake the manufacture of prunes, should experiment with varieties known to be suited to the purpose. We have no doubt that, at least for a common article, some of our different fruit dryers will answer their purpose as well as the ovens used in France.—*Am. Agriculturist.*

A LITTLE FARM WELL TILLED.

WHOEVER reflects on the abundant crop of the half-acre kitchen garden, will admit that a few acres cultivated with like care and skill would produce fully as satisfactory results as are usually obtained from the larger area of half-starved, illy-cultivated farm soil, and with less outlay of time and capital. This train of thought was started by looking over a miniature farm in this city, owned by a Boston bookkeeper, and by seeing what is obtained from it. His plot of ground measures in all but 7,500 superficial feet, or about one sixth of an acre, while 3,000 feet, or forty per cent of it is covered with buildings, leaving but 4,500 feet, or a little more than one tenth of an acre under cultivation. The live stock consists of thirty hens, whose product of eggs was $57.60, and in chickens $6.00, and which, deducting a grain bill of $45.00, left him a net profit of $18.60. His wife has a beautiful flower garden, containing between 200 and 300 plants that are a pleasure to behold.

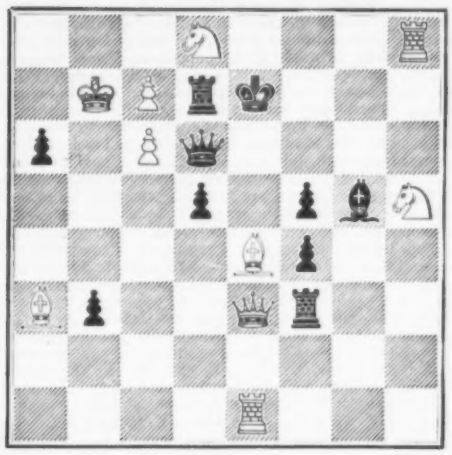
With his daily labor, from 6 to 7 30 A.M., and after 6 P.M, during the growing season, and no outlay except for one and one half cords of manure (and which the income from the hens pays for), he raises all the vegetables consumed by a family of five grown persons, and has also eight grape vines bearing two to three bushels of the best varieties; eight assorted pear trees (his Bartletts and Seckles appearing especially vigorous and thrifty) are yielding two barrels of fruit; two peach trees, two quince bushes, also currants and blackberries. Among his vegetable crops are nearly two barrels of potatoes, four varieties of corn, yielding 100 dozen for the season; sixty tomato plants, producing five bushels; seven varieties of beans, three of lettuce; also beets, cucumbers, summer and winter squashes, parsnips, cabbages, peppers, sprouts, etc.

With the production of his "little farm" he has at hand many of the luxuries of the season at really no cost beyond his own labor, which he enjoys as a healthful pastime. He, in fact, increases his annual income the equivalent of at least $150 to $200 from one tenth of an acre of land well cultivated. This is not an isolated case, but similar instances exist in the vicinity of many of our cities and manufacturing villages, and while it is not the particular product of this "little farm well tilled" to which attention is called, yet it is the practical illustration of a theory, so often advanced in these columns, that practical farming and comfortable support depend far more upon thoroughness of culture, attention to detail and concentration of resources, than upon the possession of broad acres, which the proprietor has neither the capital nor the labor to render fertile and productive.—*Boston Cultivator.*

SCIENTIFIC AMERICAN CHESS RECORD.

[All contributions intended for this department, may be addressed to SAMUEL LOYD, Elizabeth, N. J.]

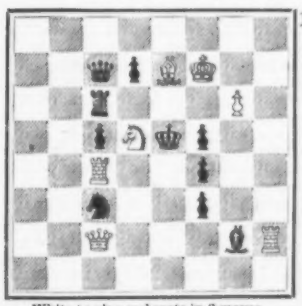
PROBLEM No. 13.—"Stand and unfold yourself."
BY JACOB ELSON.
Black.



White.

White to play and mate in three moves.

JACOB ELSON, OF PHILADELPHIA.



White to play and mate in 3 moves.
BY JACOB ELSON.

REFERENCE to our Chess Department in SUPPLEMENT No. 85 will show that Mr. Elson, whose portrait graces our gallery this week, received the prize for the second best three-move problem of the Centennial Problem Tournament, as well as the prize for the third best set, substantially the same as being second, there but one competitor ahead of him. We give the three-mover, as well as a beautiful four-move stratagem from the same set, both of which will be found to be exceedingly hard chessnuts for our solvers to crack. The initial letter is a further specimen of his R-tistic ability. As a problemist, Mr. Elson has been so long and favorably known that it is unnecessary to eulogize his compositions, which are known the world over, wherever a pretty mate is admired.

Like a true problemist, he cares more for his favorite branch of the art, although a skillful player, who could make a brilliant record for himself if he felt so disposed to waste his time. He was a successful competitor in the Centennial Paying Tournament.

CHESS IN LEIPZIG.

DURING the Anderson Jubilee at Leipzig last month the following fine consultation game was played. We are indebted for the copious notes to the *London Field*.

(IRREGULAR OPENING.)

WHITE. L. PAULSEN, DR. GERING, and METGER.	BLACK. A. ANDERSON, J. H. ZUKERTORT, and DR. C. SCHMIDT.
1. P to Q B 4	1. P to K 3 (*a*)
2. P to K 3	2. Kt to K B 3
3. P to Q R 3 (*b*)	3. P to Q B 4
4. Kt to K B 3	4. Kt to B 3
5. Kt to B 3	5. P to Q R 3 (*c*)
6. P to Q 4	6. P to Q 4
7. Q P x P	7. B x P
8. P to Q Kt 4	8. B to Q 3
9. P to B 5 (*d*)	9. B to B 2
10. B to Kt 2	10. Castles
11. Q to Kt 3	11. Q to K 2
12. B to K 2	12. B to Q 2
13. Castles K R	13. Q R to Q sq
14. K R to Q sq	14. B to B sq
15. Q R to B sq	15. P to K R 3 (*e*)
16. P to Q R 4	16. P to K 4
17. P to Kt 5 (*f*)	17. P x P
18. P x P	18. P to K 5 (*g*)
19. Kt to Q 2	19. Kt to K 4
20. Kt to B sq (*h*)	20. B to Kt 5 (*i*)
21. Kt x Q P (*j*)	21. Kt x Kt
22. B x B	22. Kt to Q 6
23. R x Kt (*k*)	23. P x R
24. Q x P	24. B to K 4
25. Q to Kt 3	25. B x B
26. Q x B	26. Kt to B 3
27. B to B 3	27. Kt to K 5
28. P to B 6	28. P x P
29. P x P	29. Kt to Kt 4
30. B to K 2	30. R to Kt sq
31. Q to B 3	31. K R to Q B sq
32. Kt to Kt 3	32. Q to K 4
33. P to B 7	33. R to Kt 2 (*l*)
34. B to R 6	34. Q R x P
35. B x R (*m*)	35. R x Q
36. R x R	36. Q to R 8 ch
37. Kt to B sq	37. P to Kt 3
38. P to B 3	38. Q to K 8
39. B to R 6	39. P to R 4
40. R to Q 2	40. P to R 5
41. P to R 3 (*n*)	41. Kt to R 2
42. B to B 4	42. Kt to B 3
43. R to Q 4	43. P to Kt 4
44. R to Q 8 ch	44. K to Kt 2
45. R to Q B 8	45. Q to R 4
46. K to B 2	46. Kt to R 4
47. B to Q 3	47. P to B 4
48. K to Kt sq	48. P to B 5
49. P to K 4	49. Q to R 2 ch
50. K to R 2	50. Kt to Kt 6 (*o*)
51. R to B 2	51. Q to R 8
52. R to B 7 ch	52. K to B 3
53. R to B 6 ch	53. K to K 2
54. R to K Kt 6	54. Q to R 4 (*p*)
55. B to B 4	55. Q to Q B 4
56. B to Q 3	56. K to B 2
57. R to Q R 6	57. P to Kt 5 (*q*)
58. R P x P	58. Q to K B 7
59. B to B 4 ch	59. K to B sq
60. R to R 5 (*r*)	60. P to R 6 (*s*)
61. Kt to K 3	61. P x Kt
62. K x P	62. P to K 7
63. B x P	63. Kt x B

Resign.

NOTES.

(*a*) In the correspondence match between London and Vienna, the council of the latter opened here with P to K 4. The move in the text is more in conformity with the spirit of a close game.

(*b*) In the above-named match Kt to Q B 3 was played early, and the answer of K B to Q Kt 5 brought the leading players into such difficulties as to produce the impression with some strong players that P to Q R 3 was an indispensable move in this opening. In the present instance the precaution seems to us, however, unnecessary, and the Kt might have been developed at once, since a comfortable retreat was open for it at K 2 in answer to B to Kt 5, to be followed accordingly by P to Q R 3 or Kt to Kt 3. At any

Jacob Elson

rate, Kt to K B 3 could have been played first with advantage, for if, then, black played P to Q 4, the answer of Q Kt to B 3 became perfectly correct, the position being analogous with many others arising in the same opening where the doubling of white's pawn at Q B 3 is even an advantage in consequence of the second player's Q P being already fixed.

(*c*) One of those routine moves which imperceptibly damage the progress of the game when not carefully weighed in relation to the position in general. As the sequel shows, the advance of this P weakened the Q wing considerably, and gave the opponents the advantage in the development.

(*d*) In our opinion white has now the best of the game. White's far-advanced pawns on the Q side are very menacing, while black's center pawns can easily be kept inoffensive.

(*e*) Black play the waiting game, and, as a matter of fact, they can nothing else.

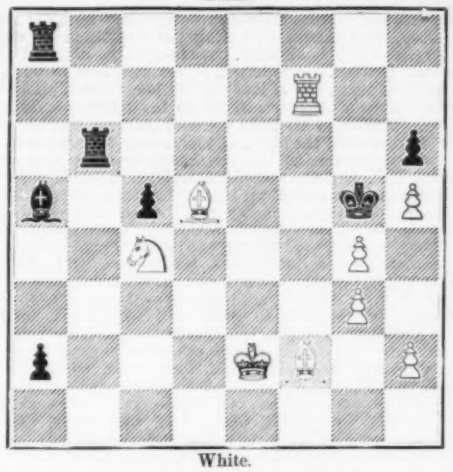
(*f*) Taking the Q P with the Kt was obviously out of the question on account of B to K 3 after retreating first the Kt.

(*g*) Black's Q P is now still made weaker, as it remains quite fixed now, and sufficient forces can be accumulated against it to win it ultimately, yet there was nothing better. Had they played, for instance, Kt to R 4, the game might have gone on thus:

WHITE.	BLACK.
	18. Kt to R 4
19. Q to R 2, threatening P to Kt 6	19. P to Q Kt 3
20. P x P	20. B x P
21. Kt x P	21. Kt x Kt
22. R x Kt	22. B to K 3
23. R x P, etc.	

(*h*) Here P to K R 3 was a necessary precaution, and white's neglecting it seriously imperils their position. The Q could not take the B P in reply to the move suggested, as white would then answer Kt x K P.

PROBLEM No. 14.—"Stand and unfold yourself."
BY JACOB ELSON.
Black.



White.

White to play and mate in four moves.

(*i*) An excellent move, which gives black a fine attack.

(*j*) White gets the worst of this capture; but whatever they did, they could not recover from having allowed their opponents' egress with the B on the K flank. Had they taken the B first, the game might have proceeded thus:

WHITE.	BLACK.
21. B x B	21. K Kt x B
22. P to K R 3	22. Kt to B 6 ch
23. P x Kt	23. P x P,

and, play as white may, they cannot prevent mate in a few moves, as black will bring next the Q to R 5, followed accordingly by Q to R 6, or Q x P ch, etc.

(*k*) The sacrifice was unavoidable. Had they moved the R to B 2, the answer would have been Kt from Q 4 to Kt 5, followed accordingly by Q to R 5, or Q x P.

(*l*) The play of the white allies, who had to defend an up hill battle, has been simply beyond praise. Whether black were prepared for the beautiful manœuvre which follows we cannot tell; but it will be seen that they would have done even worse by attempting to stop it either by R to Kt 7 or R to Kt 3, as the following beautiful variations will show. In the first place—

WHITE.	BLACK.
	33. R to Kt 7
34. Q to K B 5	34. Q to K 3
35. P to K R 4	35. R x B best
36. P x Kt	36. R x K P
37. P x R	37. Q x P ch
38. K to R 2,	

and wins, since black's R is also *en prise*.

Secondly—

	33. R to Kt 3
34. Kt to B 5	34. R to Kt 7
35. Kt to K 7 ch	35. K to R sq

It will be seen that if K moves to B sq, white would proceed in the same way as in our following analysis; only in the last move of the variation they would play the Kt to Kt 6 instead of the Q 6.

WHITE	BLACK
36. Kt x R	36. R x Q
37. R x R	37. Kt to K 3
38. Kt to Q 6,	

threatening to win the Q by Kt x P ch, and winning without difficulty; for black must now ch with the Q at R 8, and, on the B covering, sacrifice the Kt for the P, leaving white three pieces and a P for the Q, which is more than enough to win.

(*m*) This finely conceived sacrifice of the Q ought to have secured the game by rights; but white subsequently did not make the most of his defensive resources, as will be shown hereafter.

(*n*) Here is the lapsus. A weak spot is created where the Kt can be settled ultimately, however long it may take to bring it to that square. The proper mode of defence was R to K B 2, letting the P come on further, *e.g.*:

WHITE.	BLACK.
41. R to K B 2	41. P to R 6
42. P to Kt 3	42. Q to Q 8
43. B to K 2	43. Q to Q 4
44. P to B 4	44. Kt to K 5; if the Kt retreat to K 3, then B to Kt 4 follows.
45. B to B 3,	

and, after the exchange of knights, white would draw the game easily.

(*o*) The manner in which the black allies have worked their pawns and brought the knight round so as to support the present attack is highly admirable.

(*p*) Black could have won the piece; but the same must have been drawn then, for white could have taken the Kt P, and then have kept the R on the fifth row, preventing the K from crossing, while black had no means to compel the R to leave that row.

(*q*) This master stroke decided one of the most difficult ending games that we have ever come across in actual play.

(*r*) R to R 2 could not be done on account of Kt x Kt ch, followed either by Q x R, or Kt to Kt 6 ch, etc

(*s*) A splendid termination. If the K takes the P, then black would take the Kt, threatening mate next move. Whatever they may now do, they cannot save the game.